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SAL NATURAL REGENERATION IN THE UNITED PROVINCES

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There have been numerous articles in the *Indian Forester* on this subject in the past, but no contributions have appeared for the last three years. This does not mean that the problem has been solved, or that we have been standing still and learning nothing more. In his articles on "*Sal* regeneration *de novo*," published in the issues for October, 1939, and April, 1940, Mr. Smythies gave an admirable summary of the position and in the first article he quoted from my annual research report for 1938-39, in which I drew certain tentative conclusions regarding the best technique to adopt to obtain regeneration *de novo* and to get it to persist and grow up to the whippy stage in the better Bhabar type of *sal* (Champion's Type B-3). Both Mr. Smythies and I implied that this problem was approaching solution, but I confess that our optimism was hardly justified. We have succeeded over small areas, but we have not yet succeeded in carrying out by the employment of the technique we now consider best the complete regeneration of large areas from the very beginning to the established sapling- and small-pole stage. We think we can do it under favourable conditions. But there are so many places in which one or other unfavourable condition seems likely to result in considerable delay or even failure that we are certainly not yet justified in saying that we have solved, or even nearly solved, the problem for B-3 *sal* if this means that we can guarantee to regenerate *de novo* any given area within a reasonable time. But knowledge and experience of how to deal with all the varying conditions found in this type are increasing year by year and it is hoped that it will not be many years before we can put forward the claim to have solved the problem.

Most of what has been written about *sal* natural regeneration in the United Provinces has referred specifically to the Bhabar B-3 *sal*. But, leaving out of consideration the hill forests, in which natural regeneration is not generally a difficult problem, a very large area of *sal* forest, particularly in the east half of the province, is not B-3 *sal* but belongs either to the drier type, A-2, or to the moist low-level types B-4, B-5a and B-6. Experimental work in these other types has not yet advanced very far. Much of the technique applicable to the B-3 type can also be applied to these other types, but there will also be many differences, one of the most important of which will be that burning must be done much less frequently, and sometimes not at all, in the drier A-2 type.

Three years ago it was intended to start a large number of new experiments, both in B-3 *sal* and in the other types, particularly the drier A-2 type. This would have enabled us to test out our latest theories for B-3 *sal ab initio*, and also to work

out the technique required in the various other types. Unfortunately, the shortage of staff, time and money resulting from our intensive war work has prevented much further progress being made and research work on *sal* regeneration has, in consequence, been more or less stagnating during the last few years. There has, however, been some development of ideas, and it may be useful at this stage to record some of my personal ideas, which I have recently embodied in the form of general instructions to be included in working-plan prescriptions for *sal* working circles prescribing natural regeneration under a shelterwood. I give these instructions below in the form in which they have appeared in several recent working plans except for a few minor alterations necessary to make them suitable for inclusion in this article.

METHOD OF TREATMENT IN SAL NATURAL REGENERATION AREAS

1. The following suggestions are made for the operations to be carried out in *sal* regeneration areas.

2. (*a*) *Where patches of established poles and saplings exist.*—The treatment is obvious. If well-grown and fit to leave as they are, they should be freed from overwood and thinned and cleaned. If they are badly grown and are incapable of producing a healthy crop at maturity, they should be cut back and the resulting coppice tended by annual shrub-cutting and strict fire protection, the overwood and middle storey being suitably opened to give it enough light. In areas where frosts occur care should be taken to leave enough overwood and middle storey to protect the coppice from frost damage and, if necessary, some of the poles themselves should be left to ensure sufficient protection.

3. (*b*) *In areas where large whippy shoots or suppressed woody plants of sal exist in sufficient quantities.*—There is no doubt that the regeneration can be got up by suitable opening of the canopy, game-proof fencing, intensive annual shrub-cutting and fire protection. In most of our *sal* forests deer-browsing is sufficiently bad to make game-proof fencing essential or, at any rate, advisable. There are some areas where it may not be necessary but, in the following description of the treatment to be applied, it is presumed that it will be required.

The technique at present considered best is detailed below, but the territorial staff should keep in touch with the Working Plans and Research Circle and thus obtain information of the latest developments:

(*i*) The overwood is generally reduced to 25 to 30 trees per acre, *i.e.*, trees are left as evenly spaced as possible—about 40 to 45 feet apart. This is an average and the number to be left will naturally vary and will depend on the size of the trees in the overwood, the size of the regeneration and the degree of frost danger. The miscellaneous middle storey is also heavily thinned and shrubs are cut, if too dense, and badly-shaped advance growth is cut back.

(*ii*) The area is control-burnt departmentally about the end of March or early April, then fenced and fire-protected. If proper game-proof fencing of wire is unobtainable, a possible substitute is a high fence of thin poles bound together with plain wire.

(*iii*) Rains shrub-cutting is done annually to help *sal* regeneration from suppression by weeds until it reaches the sapling stage and is above the level of competition by surrounding shrubs and weeds. Where rains shrub-cutting is not possible due to labour difficulty, two shrub-cuttings are done, one in winter between November and February and another in summer between April and June.

(*iv*) As *sal* regeneration grows up into the sapling stage, the overwood is gradually removed until the area is completely regenerated, when the entire overwood is felled.

4. (*c*) *In areas where sal regeneration is absent or deficient.*—Efforts will be made to complete regeneration where it is deficient and to obtain regeneration *de novo* where it does not exist. Research is in progress to discover the best methods to employ in various types of *sal* forest for obtaining regeneration *de novo* and getting it to persist and grow up to the whippy stage. Nothing definite can yet be prescribed as the problem has not yet been solved. Although much has been and is being learnt from the silviculturist's experiments in various divisions and from the work being done by divisional forest officers in Haldwani, Ramnagar and other divisions, ideas are constantly changing and the Working Plans and Research Circle should be consulted from time to time, so that the territorial staff can keep in touch with the latest developments.

5. Present ideas are as follows:

For *sal* regeneration in its early stages a canopy of nothing but high-crowned *sal* with all middle storey and shrubs cut away is most unsuitable. What is wanted is a mixed canopy with trees and shrubs of all heights. The upper canopy of high-crowned *sal* (with miscellaneous species here and there if they exist) should be well-broken, the degree of opening depending on the state of regeneration and the amount of miscellaneous middle storey available. With a fair amount of miscellaneous middle storey present and for regeneration *de novo* a "D" grade thinning in the *sal* with the addition of about eight permanent gaps per acre, each gap being about the size of the crown-space of a large mature dominant tree, will be sufficient opening. But if regeneration older than one or two years exists already, a heavier opening will be required, varying in intensity with the size and amount of regeneration. If miscellaneous middle storey is deficient, the number of gaps in the upper canopy should be fewer. Below the upper canopy a middle storey should be left of *dhauri* (*Lagerstroemia parviflora*), *amaltas* (*Cassia fistula*), suitable light-crowned *rohini* (*Mallotus philippinensis*) and any other available light-crowned miscellaneous species and, if possible, these trees should have more or less clean stems up to 10 or 20 feet and should not have low spreading branches. This middle storey should be well scattered or in small, open groups and it is especially important to have it under or near the edge of gaps in the upper canopy, particularly if these gaps are unavoidably larger than normal. Shrubs below about 10 or 15 feet high should not necessarily be clean-cut but should generally only be thinned out and lopped where too dense. Clean-cutting may, however, be necessary where they are really dense and of the evergreen type. It must be emphasised that once a forest has been brought into the above condition, it will need constant attention to keep it from becoming too dense again and it will need further opening out as soon as the regeneration develops after a few years.

6. The importance of keeping a middle storey of miscellaneous species and scattered undergrowth of shrubs has been emphasised above. The chief advantages of this are:

(*i*) *Sal* seedlings not only germinate better, but grow and develop better under miscellaneous species than under *sal* (provided the foliage of the miscellaneous species is not too dense). This is probably chiefly due to the lighter shade of most miscellaneous species and because their leaves are generally smaller and not so hard and leathery as those of *sal*, the latter preventing *sal* seeds getting to the ground and also taking longer to decay and causing bad aeration of the soil.

(*ii*) The miscellaneous species prevent heavy drip, which occurs if there is nothing in between the high *sal* crowns and the ground; heavy drip hardens the ground and has often been observed to be bad for *sal* seedlings.

(*iii*) The miscellaneous species keep down weeds and grass without unduly suppressing the *sal* seedlings. If *sal* by itself is sufficiently dense to keep weeds and grass from becoming too thick, then it generally also suppresses the *sal* seedlings, where suitable miscellaneous species do not do this to anything like the same extent.

(*iv*) The miscellaneous species protect *sal* seedlings from drought and the effects of exposure to a hot sun. Without such protection *sal* seedlings frequently die off in large numbers. This is probably the most important advantage.

7. Game-proof fencing is not generally necessary until the regeneration reaches the whippy stage. But departmental burning will generally be necessary, though in areas of a dry type, and especially where grass growth is apt to be heavy, burning should be done sparingly; this also applies to many poor-quality areas with a clay soil which, though apt to be waterlogged in the rains, frequently suffer from excessive dryness in the dry weather and do not therefore, have a dense undergrowth. Apart from removing accumulations of dead leaves, grass and undergrowth to make a clean bed for the *sal* seeds, the chief advantage of burning is to keep the undergrowth in check. Thus, in the moister areas, where the undergrowth tends to be of the dense evergreen type, annual burning will probably be necessary, both for a year or two before fellings and again after fellings until sufficient regeneration has reached the whippy stage, and burning should, if necessary, be preceded by a shrub-cut if the area would not otherwise burn well. But in the drier and more grassy areas annual burning is apt to do more harm than good, and it may be advisable only to burn before good seed years or even to do no burning at all It must be emphasised that burning should never be allowed to become a routine measure to be done annually as a matter of course. It must be decided each year for each area whether burning is likely to prove advantageous or not.

In areas where annual burning is done it may be advisable to stop burning for one, or possibly under certain conditions for two years after a good seedling year, and only do shrub cutting. It is not yet known exactly under what conditions this is advisable, but in the moister, more evergreen areas it may be better to continue burning in order to prevent the undergrowth from becoming too vigorous, as in such areas it is probable that a certain percentage of the recruitment will survive and that there will be an increase of seedlings after each good seedling year in spite of the burning.

8. Thus, after the first felling as described in para. 5, burning and shrub-cutting will be continued as required, being varied according to the type of area and condition of the regeneration and undergrowth, and further fellings in the over-wood and middle storey will be carried out as the regeneration develops. Then, when regeneration in sufficient quantities has reached the large-leaved whippy stage, the treatment indicated in para. 3 (modified, if necessary, as a result of subsequent experience) will be applied.

THE SILVICULTURE OF *CASSIA SIAMEA*

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INTRODUCTION

Enquiries are often received for suggesting quick-growing species for fuel plantations. Information on many of the suitable species is nowhere comprehensive. *Cassia siamea* is one of the suitable species for the purpose, and the present note is meant to meet the need of the enquirers.

Botanical.—*Cassia siamea* belongs to the order *Caesalpinieae* of the *Leguminosae*. The leaves are pinnate and the number of petals is 5, the stamens being partly imperfect and unequal. Leaflets 6 to 10 pairs, chartaceous, elliptic-oblong, tipped with a minute sharp mucro, sometimes emarginate, glabrous on both sides, 1½ to 2½ in. long, stipules caducous. Racemes often corymbose, arranged in a large pyramidal terminal panicle, often 2ft. long, pedicels ½ to 1 in. long, bracts stiff, linear, much shorter than pedicels. Flowers yellow, petals ½ in. long. Pod flat, thickened at sutures, minutely velvety, 4 to 10 in. long. Flowers appear mainly in the hot season, but the flowering period is comparatively long and flowers may often be found at various seasons. Pods ripen towards the end of the hot season.

Uses.—*Cassia siamea* is one of the Indo-Malayan timber species.

Timber.—Wood hard, sapwood whitish, rather large; heartwood darkbrown and streaked on radial section. On a tangential section the dark patches appear as zigzag plates and this is the section which would be most handsome in joinery work. The pretty wood is, however, not usually of large dimensions for extended use.

In Nigeria, it is used for pit-props, in Burma for helves, walking sticks, mallets, in Java for bridges, etc., and in Sumatra for posts and bridges.

Fuel.—When introduced outside its natural habitat, its chief use is for fuel and occasionally for temporary buildings. It is the chief wood used for fuel in locomotives in Ceylon. It is also said to make good charcoal.

Fodder.—It is classed as good fodder in Bombay and as medium fodder in Orissa. The leaves are eaten by cattle, sheep and goats. There is an alkaloid in the pods and leaves which has been recorded as fatal to pigs. Black buck have been known to browse *Cassia siamea* and there is some suspicion of the barking deer browsing the species. *Sambhar* and spotted deer, however, have nowhere shown a liking for it. They taste it and reject it (Madras).

Vegetable.—It is said that the flowers may be eaten in curries.

Tannin.—There is tannin in the pods to the extent of 6 per cent., in leaves to 7 per cent., and in the bark to nearly 9 per cent.

Medicine.—The heartwood is laxative.

Lac.—The lac insect feeds on the tree.

Sandal Host.—*Cassia siamea* is considered a very suitable host for *Santalum album* specially as it also kills out *lantana*.

Avenues.—It has been cultivated for ornament and for roadside planting also, although for the latter it is objected to as not being permanent enough.

Nurse.—*Cassia siamea* may be emloyed as a first nurse for mahogany to reduce borer attack, then as coppiced undergrowth.

Suppression of Imperata cylindrica.—*Cassia siamea* grows through *lalang*, according to Malayan experience, and kills it. It is never entirely leafless, but will only kill out grass cover under favourable conditions if it does not receive a setback in the early stages.

Wind-break.—It forms good windbreaks in Northern Rhodesia.

Resists Termites.—In Uganda, *Cassia siamea* continues to be an important species in many districts where Eucalyptus do not grow well or suffer excessive losses from termite attacks.

Leaf Manure.—In Madras *Cassia siamea* is planted by private owners for lopping for green manure.

DISTRIBUTION, LOCALITY AND TYPES OF FORESTS

Elevation—

Locality		*Elevations at which found or grown.*
Ceylon	...	Low country up to 2,000 ft.
Mauritius ...	...	Up to 100 ft.
Nigeria (eastern provinces)	...	600 to 700 ft.
Nyasaland ...	...	1,500 to 3,500 ft.
Rhodesia (northern)	...	At foot of hills at 4,000 ft.
Sierra Leone ...	...	On western and southern aspects up to 1,000 ft.
Tanganyika ...	...	In all situations from sea-level to 4,000 ft., but chiefly between 300 and 1,000 ft.

Cassia siamea should not be grown above 4,500 ft., as it is expected to be not much more than a large branchy bush at this height.

Rainfall.—

Locality		*Particulars of annual rainfall in places where Cassia siamea grows.*
Cyprus ...	...	25 to 70 inches (April to October).
Mauritius ...	...	Will not stand more than 60 inches.
Nigeria (eastern provinces)	...	60 inches (May to October).
Nyasaland ...	...	20 to 40 inches (December to April).
Rhodesia (northern)	...	37 inches (November to April).
Sierra Leone ...	...	130 inches (May to October).
Tanganyika ...	...	25 to 30 inches (April, May and November).

Fig. I

Cassia siamea regeneration in the 3-acre *rāb* and in *lantana*—in Coupe I, Denkanikota, showing the portion burnt. The background is fully burnt by fires on 4-3-39. Madras.

Photo—S. Rangaswami.
5-3-1939.

Fig. II

1933 *sandal* kumri. Sown 18 ft. × 12 ft with *Cassia siamea* planted round each *sandal*. *Sandal* 15 ft.—25 ft. high. *Cassia* has greatly outgrown *sandal*—35 ft.—40 ft. and has been lopped to free it. Dense *Cassia* keeps out *lantana*. Thinned to 40 trees per acre Balecove, South Coorg.

Photo—M. V. Laurie,
30-1-1940.

Cassia siamea is said to need, generally speaking, a mean annual rainfall of about 1 m. or 40 inches for good development.

Temperature.—*Cassia siamea* is capable of thriving under a variety of climatic conditions within the tropics. In areas where it flourishes, however, frost is unknown, but where frost occurs, as in low-lying situations, in northern Rhodesia, it suffers damage. It can thus only be raised at great cost, in such localities, where frost occurs due to the need of providing protection in the early stages. Plants in the experimental garden at New Forest, Dehra Dun, in the open invariably died of frost although heavy overhead shade often gave almost complete immunity to it. The botanist was able to raise only one plant in his garden. Frost is, of course, nearly annual at Dehra Dun.

Soil.—*Cassia siamea* prefers moist soils with good drainage. In Mauritius, it grows on black clay soils. In the eastern provinces of Nigeria, the oldest plantations are on red tropical earths, overlying tertiary sandstones. In northern Rhodesia it occupies light loams overlying schistore rocks and in Sierra Leone it occurs on lateritic gravel over syenite rock, weathered syenite and granite.

The species is, however, not adaptable to every soil. Repeated failures have been noted on soil in which the ironstone concretions (laterite) come to within 12 inches or less from the surface. On such areas very poor growth is attained, the foliage is thin, the trees become stagheaded in 4 to 5 years, and the coppice growth yields a low return of firewood. These stunted trees are further unable to kill out the grass which rapidly invades cleared areas.

Types of forests.—*Cassia siamea* is common in the forests quite at the south of the Madras presidency, mixed and dry forests of Burma, and chiefly in the moist region of Siam and the Malaya peninsula and archipelago.

AFFORESTATION

In Sierra Leone, *Cassia siamea* is used for the re-afforestation of the savannah. In Tanganyika it has proved useful in the afforestation of bare unproductive lands.

For the afforestation of areas infested with *Lantana*, a good scheme worth trying in localities suitable for *Cassia siamea*, is to sow it in lines 6 ft. apart after the first yearly eradication of *Lantana*, and if fuel has no market value to introduce sandal quincunx in the following year.
(See Figs. I & II, Plate 1.)

NATURAL REGENERATION

Natural regeneration by seed.—*Cassia Siamea* reproduces naturally by seed.

Natural regeneration by coppice.—Coppice growth is the established method of regeneration in the fuel plantations. At Ibadan, where the rainfall is approximately 50 inches and good average soil conditions are present, the fuel plantations are worked on a 10-year coppice rotation.

In Mysore coppicing mostly crooked trees of 3 to 4 feet in girth gave very good results, producing clean, straight shoots of 9 in. to 1 ft. in girth in one season.

ARTIFICIAL REGENERATION

Seed collection.—In Ceylon the months of flowering are March—June—August—November and of ripening of fruit May and October to November. Seeds are collected principally in May—July and also in December.

In Madras the seed is collected in March—April. Seeds weigh 1,050 (Madras), 1,060 (Africa) to the ounce.

Large amounts of the seed are collected in Bunyoro (Africa) at all times of the year.

Seed supply.—Seeds may be obtained from the provincial silviculturist, Madras, Ootacamund. The seed may also be obtained from Mysore and Ceylon.

Seed storage.—The seed retains its viability for several years (Africa). Seed-storage tests in Madras have shown that the seed is good even after three years of storage. It keeps best in airtight tins.

Seed treatment.—The germinative capacity of the seed was found to be 98 per cent. (Madras). In another set of tests it was found to be 50 per cent. for untreated seeds and for treated seeds was found to be 37 per cent. (cold water), 47 per cent. (hot water) and 5 per cent. (boiling water). Where direct sowing is done and rain comes in storms with alternate dry periods, seed treatment before sowing is not advisable.

Methods of stocking.—Direct sowing is the best method of raising plantations of *Cassia siamea*, though stump planting is also resorted to in suitable localities where a well-balanced rainfall in the first three months after sowing is unobtainable.

The results of experiments carried out in Madras, in 1933, 1934 and 1935 relating to the choice of the general method of regeneration for *Cassia siamea*, indicate that sowing is the best method to use:

	Sowing	Transplanting	Stump planting
Survival %	55	20	21
Mean height in inches ..	4·8	2·5	3·2

The best date of sowing was found to vary as follows, in the Emmanur experimental gardens, Madras (average annual rainfall 30 in. from the south-west and the north-east monsoons).

Year of sowing	Best date for survival % (Sur. % in brackets)	Mean height (Mean ht. in inches in brackets)
1934	1st July (88%) .. 1st August (79%) ..	1st July (3"). 1st August (3").
1935	1st August (96%) .. 1st July (86%) ..	1st September (3·1"), 1st August 9·8").
1936	1st July (87%) .. 1st August 86%) ..	1st August (4·6").
1937	1st October 86% .. 1st August (70%) ..	1st May (18·6").
1938	1st August (99%) .. 1st June (95%) ..	1st August (18·0").

These dates, of course, cannot be of guidance for other localities. The best date for any locality, however, can be ascertained by a simple nursery bed experiment, in which two rows may be sown with seeds, in say, 4 replicated blocks each block containing a full set, for each of the various dates, the rows for each date being selected strictly at random and repeating the experiment, in say 2 more seasons, to confirm results obtained in the first year.

Variation in the depth of sowing seeds from ¼" to 2" has no appreciable effect on the percentage of germination.

In experiments carried out in Madras in 1934, 35, 36, 37 and 38, burning before sowing was found to be highly beneficial. Brushwood was piled to a height of 5 to 6 feet for the purpose, beaten down to a height of about 4 feet with heavy sticks and then burned in June.

Ridge sowings at site have proved both cheap and simple. Parallel ridges are made 6 ft. apart and at least 1 ft. high—the higher the better. When the rains have begun seed is sown sparingly on the ridges. Towards the end of the rains the seedlings are thinned to a spacing of 1 ft. and at the beginning of the next rains they are again thinned to a spacing of 6 ft., the best plants out of the thinnings being stump-planted in other areas.

Delhra Dun experiments indicate that the species cannot, however, be stump-planted under shade, though it gave 59 per cent. to 86 per cent. success in the open in 1937 and 1934 respectively.

EXTERNAL DANGERS AND PROTECTION

Insects.—It is rarely attacked by insects, even under the most favourable conditions (Nyasaland).

Indian records are as follows:

Xyleutes persona is a beehole borer of *Cassia siamea*. *Zeuzera coffeae* is a borer of the woody stems of its young saplings and the living branches. Defoliators are *Catopsilia crocale*, *C. pyranthe and Diapromorpha balteata* *Cassia siamea* in almost all the *rabs* (Chittoor division, Madras) has been attacked by an insect identified as *Celosterna scabrator*. For control measures a reference may be made to "The ecology and control of the forest insects of India and the neighbouring countries," by Dr. C.F.C. Beeson, Vasant Press, Dehra Dun.

Fire.—*Cassia siamea* does suffer from fires (Tanganyika).

Fungi.—The tree is susceptible to a fungus attack which has been identified as *Gandoderma lucidum*. Fungus attack is believed to be secondary, having started only when the plant was about to die.

Wind.—*Cassia siamea* is brittle and liable to be broken and uprooted by wind (Mauritius).

Drought.—The capacity of the tree to stand drought is dependent on the rainfall limits that govern its growth and development. It has been stated in an earlier section that the rainfall lower limit for it is 1 m. or 40 inches. In Cyprus it is not considered as drought-resistant: it dies back in prolonged dry spells where the rainfall is less than 35 inches. Cyprus experience is thus in conformity with this view.

In Mauritius it will not stand more than 60 inches of rainfall, but resists drought. In northern Rhodesia the tree is considered as drought-resistant and in Nyasaland it has proved more drought-resistant than any other exotic species yet tried.

Prolonged drought after germination is, however, bound to prove fatal. Thus in an experiment in Tinnevelly, Madras, in 1930, germination was 50 per cent. but all seedlings died of drought as there was no rain for about two months after germination.

STATISTICAL

Locality	*Dimensions attained by Cassia siamea*			
	Age of plants yrs.	Height ft.	Girth at b. h. : in.	Stacked volume per acre
Sukna, Bengal, Altitude 550 ft. Annual rainfall 148·8 inches	4	25	14″	
South Cuddapah, Madras ..	3	..	18″	
Cyprus	4	20	..	500 c.ft.
Mysore	1	8 or 9	..	
Nigeria (eastern provinces) ..	..	9 annually	..	
Northern Rhodesia	..	4 annually	..	
Tanganyika	6	22	..	
	18	..	..	612·0 c.ft.
Ibadan	10	..	..	*18 cords.

* Selling price 10s. per cord.

The following data are obtained by converting metric figures to English feet and inches and cu. ft. from pages 696–701 of Tectona of 1936. The culmination of the mean annual increment is in the 6th year:—

Cassia siamea

Age	*Mean height*		Mean diameter	Mean thick wood volume per acre
	Good site	Bad site		
Yrs.	Ft.	Ft.	Ins.	C.ft.
3	30	15	..	..
4	39	17	..	..
5	48	19	4·2	1229
6	54	20	5·0	1429
7	60	21	5·7	1615
8	64	22	6·5	1786
9	68	23	7·2	1929
10	71	24	8·0	2058
11	73	24	8·8	2158
12	75	25	9·5	2244
13	76	26	10·0	2315
14	76	27	10·5	2358
15	76	..	10·9	2415
16	76	..	11·1	..
Number of sample plots ..	5		5	3
Number of measurements ..	10		10	8

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THE MYSORE FOREST RANGER SCHOOL

By Dr. Kadambi Krishnaswamy,

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The class social of the school was held in the premises of the forest research laboratory, Bangalore, on 29th September, 1943, under the presidency of Mr. C. Abdul Jabbar, chief conservator. After tea and a group photograph, all members of the school staff, examiners and the students assembled in the lecture hall of the school. Among those present were Mr. C. Abdul Jabbar, C.C.F., Mr. P. Krishnaswamy Rao, C.F., Mr. M. A. Muthanna, D.F.O. Shimoga.

After invocation the principal of the school read his report. The strength of the school was eleven students. All the boys are graduates in science. The length of the training was 20 months. Eleven months were spent in the field and nine

months at headquarters. At headquarters lecture classes were held by the officer-in-charge of working plans and forest surveys, who is also the principal, the assistant principal, the forest mycologist, the forest chemist, the technical assistant to C.C.F. and others. While on tour the principal and the assistant principal accompanied the class, the former, being a part-time officer, spent only a portion of the time each month with the school, but the latter was present throughout. The daily routine of the school in camp consisted of an hour's lecture in the morning, followed by practical fieldwork till evening with a short break for lunch. After each item of practical work was completed, detailed notes were written up by the students on the work done and these were corrected by the principal or his assistant and returned to the boys in the open class, bringing to the notice of each student any mistakes committed. During this a free discussion and criticism of one another's observations took place more or less like in a "seminar." This system proved very useful in improving the powers of observation and originality of the students.

There were also two study tours outside the state, one to the Nilgiris in March, 1942, and the other to south Kanara, Malabar and Nilambur, of about three weeks' duration, during April and May, 1943. They were of much educational value.

The principal then pointed out that certain additional facilities were required for the school. He stated that independent accommodation for holding the classes and some equipment for the school would be advantageous. Adequate medical aid in forest camps and a drill instructor were also necessary.

He then thanked the head of the department for his unceasing interest in the welfare of the school and all his colleagues for their co-operation, and concluded by wishing all the students a successful career in their professional life.

Mr. K.M. Subbiah, one of the students, then spoke on behalf of them.

A speech by the chief conservator followed. He advised the students to make good use of the knowledge acquired by them in the school, prove worthy of the training they had undergone and keep up their powers of observation and study.

The principal then announced the results of the examination by reading out the names of the successful candidates in the order of merit, as below:

Honours

1. N.K. Anantanarayana Iyer, M.Sc.
2. K. M. Subbiah, B.Sc.

Pass

3. T. S. Revanna, B.Sc.
4. B.K. Cheluvarajan, B.Sc.
5. K. N. Ramaswamy, B.Sc.
6. C. B. Onkarappa, B.Sc.
7. L.S. Vasudeva Murty, B.Sc.
8. B. Baliah, B.Sc.
9. M. Basappa B.Sc.
10. B.S. Siddalingiah, B.Sc.
11. S.K. Khadar Navaz Khan, B.Sc.

The pleasant function terminated by calling three cheers to the chief conservator.

EXTRACTS

THE NUTRITION OF THE FOREST CROP*

By S. L. Kessell.

The forester working in a new country is required to assume the dual rôle of scientific investigator and forest manager. It is not possible in practice to delay large-scale operation in forest regeneration, forest protection and the establishment of exotic plantations until the final results of experiments designed to elucidate silvicultural problems are available. In this regard the forester is at a serious disadvantage owing to the long period between germination and maturity of the plants which comprise the forest crop.

Some seventy or eighty years ago,[1] when the practice of forestry in Europe started to emerge from the realms of empiricism, European foresters had the advantage of several centuries of careful observation which had provided a working knowledge of measures necessary for the successful development of forests of economic importance in those regions. Subsequent research work in many fields of science has resulted in a better understanding of the principles governing the healthy growth of plant communities. This in turn has led to improved technique in the management of forests, but it has not brought about the same notable developments as have occurred in agricultural practice during the same period.

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* This paper was prepared in 1939. Owing to the war the meeting at which it was to have been delivered has been postponed indefinitely and Mr. Kessell has made it available to the Institute for publication. Owing to the onerous nature of his present duties as Controller of Timber for the Commonwealth, Mr. Kessell has had no opportunity to make any revision of the paper as prepared in 1939.—*Editor.*]

There are several reasons for this, the first and principal one being that the empirical methods developed by past generations of foresters were proved for the most part to be sound in theory and practice. Other reasons are associated with the long rotation of the forest crop, which makes it difficult to justify more than a minimum of expenditure on treatment if a satisfactory financial return is to be obtained by the forest owner, State or private, from the investment.

For the successful and economic management of forests in a new country it is necessary for the forester not only to know the silvicultural methods used in older countries but also to understand the reasons for those methods. For guidance in such matters the forester must examine the rapid advances made during recent years in the realms of plant physiology, plant ecology, bio-chemistry, pedology, and other allied sciences, pure and applied. In consequence, major research projects in forestry, as in other branches of applied science, have developed into undertakings which can be handled adequately only by teams of specialists working under the leadership of men of wide vision with a grasp of practical issues, and forestry is handicapped by the small number of institutions in any part of the world organised on these lines and interested primarily in the application of research work in the associated sciences to the forest crop.

Agriculturists have learned that laboratory results can rarely be translated direct into farming practice and that an intermediate stage of field experimentation under strictly-controlled conditions is necessary. The same principle is of even greater importance in forestry, where treatment applied to a tree crop may make or mar its growth for many years, and in addition the forester is always faced with the bogey of costs accumulating at compound interest between the time of treatment and the marketing of the crop. For such reasons it is of paramount importance that forestry field experiments be properly designed and the results examined for reliable interpretation by statistical analysis. While the application of modern biometrical methods is an essential requirement of sound experimentation in problems of tree growth, much useful information of practical value will continue to accumulate from observations made by practising foresters. Such men, with a gift for seeing and interpreting the ways of nature, are able to indicate the trends which organised experimentation should follow. When such work reaches the stage when conclusions can be drawn, it is important to observe always that the results of experiments apply to the particular region in which the experiments were carried out, and great caution is needed in attempting to apply the results obtained to other forest regions or even to different forest types or soil types within the same region.

Toumey has enunciated the basic concept of modern silviculture as follows: "Forest vegetation is composed of plant communities or units of vegetation developed and arranged in accordance with definite biological laws and is not an aggregation of trees and other plants brought together by chance." The teaching and practice of forestry on this basis has represented a great advance, but the full implications of the concept are frequently missed by research workers as well as practising foresters. The importance of listing all the factors which may influence the growth and wellbeing of the members of the forest crop before proceeding to the study of individual trees is frequently overlooked, and the value of experimental work marred by the failure to recognise the interaction of other factors masking the responses attributed to

the treatments under test. Furthermore, the practical value of an experimental result can only be judged by a forester with an intimate knowledge of field conditions.

Another frequent fault is the desire to explain numerous phenomena of disordered growth of trees or forests by a single causal factor, leading to disappointment in the results of remedial treatment. The probabilities of finding a panacea are no greater in forestry than in medicine, and it is equally important in both sciences to recognise the need for studying individual symptoms and endeavouring to trace each back to underlying causes which may contribute to a general condition of normal or abnormal growth as the case may be.

Trees have played an important part in the development of the earth's surface to its present state. Down through geological ages vast forests have covered the changing continents, drawing mineral salts from the soil and redepositing the material converted into plant tissue on the surface of the ground to become mineralised again. This cycle, which is common to all forms of higher plant life, has contributed largely towards the evolution of a globe suitable for the habitation of civilised man. One consequence of the process not realised until recent years has been the extent to which it has been responsible for the multiplication of soil types. Within the past 30 years the work of the Russian School of Soil Science has resulted in a general acceptance of climate as the most important factor in the formation of widespread soil types. Most recent studies of pedologists have modified this view to some extent, and it has been demonstrated that, under the same conditions of climate and parent material, different vegetative types may cause the formation of entirely different soils. Given uniform conditions, not only will the soils formed below open grassland differ from soils developed under forest, but the soil formed under two distinct forest types may prove equally distinct. These changes, which develop during long periods of comparative stability of vegetative types, are not to be confused with the much more rapid changes in soil fertility resulting from human interference with natural vegetative cover which are discussed later in this paper.

It is necessary that any fundamental study of the nutrition of the forest crop should be directed first towards an understanding of the various stages of this cycle in which the tree draws from the soil mineral salts in solution. These are converted into organic material by combination with atmospheric carbon and returned to the surface of the soil as an accumulation of humus. This in turn becomes steadily mineralised and, in the process, plays an important part in expediting or retarding the further leaching of the upper-soil horizons. A large number of papers have been written on the effect of vegetative cover on the chemical and physical constitution of soils in all parts of the world and, while investigators may differ in the explanations offered of the chemical processes which take place, certain general principles are now generally accepted. Some of these are in conflict with teachings contained in certain forestry text-books still in general use.

Pedologists accept the superiority of grass over forest vegetation in increasing soil fertility, and consider that, while certain forest types may be soil-improving, others result in soil impoverishment. The latter may apply to virgin forests growing high-grade timber and in an ideal silvicultural condition in the accepted sense of that term. Glinka and his fellow workers in Russia, followed later by other European investigators, have described the podsolisation processes leading to the development

of the forest gray soils of Europe and Asia as a concept of soil degradation. Earlier observers, including Scandinavian and German foresters, described podsolised soils but were at a loss to understand the presence of layers of leached white sand at varying shallow depths in certain of these forest soils and went so far as to describe the light-coloured horizons as an independent geological stratum brought in by winds or laid down by water.[3] Later researches have shown that, when certain forest types, generally coniferous, encroach on grasslands of the steppe or prairie type, the podsol process of soil formation sets in as soon as the forest cover is capable of keeping the accumulated humus layer moist. The organic acids present in moist and decomposing leaf litter react with the soil minerals and, in the course of complicated chemical reactions, mineral and organic substances, including plant nutrients, are carried downwards in true and colloidal solution, leaving behind a leached silica layer. Deposition of certain fractions occurs at lower levels, resulting in clay accumulation and the formation of compacted layers of which hardpans may be regarded as the extreme condition.

If the cementation of this illuvial horizon proceeds to an extent that an impermeable layer is formed, then both soil and vegetation undergo further drastic changes. The soil ceases to be normal podsol type, an essential condition of which is good drainage, and the layers above the hardpan become waterlogged for long periods, leading to the disappearance of forest to be replaced by heath vegetation and the formation of peat. During this phase minerals accumulate in the soil. Muir[4] has pointed out, following the examination of certain soils of this type in Scotland, that their fertility level is satisfactory to the growth of forest trees such as larch and spruce, provided adequate drainage is restored by breaking the hardpan with deep ploughing, explosives, or other means. He advocates the planting of birch for the improvement of impoverished podsolised soils in such regions in mixture with conifers, in order that the base content of the surface horizons of the soil may be kept up during the whole period of the crop.[4]

Another important soil group associated with forests of the temperate regions of the northern hemisphere are the brown earths. The development of soils of this type, having a much higher fertility level than podsols, are due in some instances, to the occurrence of forests of broad-leaved deciduous trees, instead of conifers, but these soils[3] are associated generally with slightly different conditions of parent rock and climate to the podsol group. In regions where soils of the brown earth group are prevalent, the occurrence of warm and dry periods leads to periodic ascent of ground water and higher calcium content in surface layers restricts leaching. As a result, phosphates and other minerals are retained in the soil. Many pedologists, who have described brown earths, have noted their association with beech forests and Glinka[3] states that the percentage of ash in beech litter is 5.57 compared with 1.46 in pine litter, and that the beech ash contains 2.46 per cent. of calcium oxide compared with 0.59 per cent. in pine ash. It is inferred therefore, that the calcium oxide and other bases present in such high amounts in beech litter replenish the leached soil bases and constitute a hindrance to the process of podsolisation. More recent papers[5] on the subject have expressed the same idea in general terms of higher base content, better buffer characteristics, and lower acidity of the hardwood litter having a more favourable influence on the soil than softwood litter.

Similar phenomena have been noted in New Zealand, where the nature and composition of leaf fall is considered to have a marked effect on soil formation. In the north Auckland region[6] three main types of forest floor have been recognised. Under dicotyledonous trees such as puriri and taraire a loose litter of dead leaves directly overlies the mineral soil, and contains the higher percentage of lime and potash. Under podocarps and related trees such as rimu, totara and miro, the litter is of an intermediate type and does not decompose so readily, having a powdery humus layer separating the layer of fresh litter from the mineral soil below. Kauri, a conifer, produces the most acid type of humus, resembling a greasy peat, in the lower strata. From the same parent material puriri is regarded as producing the most fertile soils, and kauri the least fertile.

The published work of soil scientists in the United States provides numerous confirmatory instances of the development of better-class soils under prairie than forest,[7&9] other conditions being similar, and of the higher base content of the leaf litter of Northern Hemisphere broad-leaved trees than pines of the same region. Always, Kettridge and Methley,[8] in a joint paper, state that, in Minnesota forests, the percentage of lime in litter, duff, and leaf mold under a mixed maple basswood stand was five times the percentage under Jack and Norway pine forests. The nitrogen content was one-and-a-half times higher and phosphoric acid, potash and sulphur were present in much greater quantity under the broad-leaved hardwood species.

M. J. Plice,[5] working in the forests of the States of New York and Pennsylvania, has listed the broad-leaved trees and conifers met with in the study in order of soil-improving qualities of their litter, which does not always compare favourably with the litter of their European relatives. At the same time, he considers, in the region in which he worked, site factors may easily offset the specific effect of tree cover, and postulates that there are intermediate or transitional zones, such as large areas in the North-East of the United States, where tree-cover influences humus conditions and soil development much more than in other zones where climate and geology more rigidly predetermine type of humus and soil. It is a fortunate circumstance in the New York State that selective logging favouring the development of the more valuable hardwood species of bass and yellow poplar may mean not only improvement in the value of the stand but also in the productivity of the site.

In a still more recent series of studies of forest soils of West Virginia, U.S.A.,[10] Broadfoot and Pierre found that fresh litter from different forest-tree species varies considerably in rate of decomposition. Chemical analyses of the leaves and needles representing 19 species showed that, although some variation exists in the chemical composition of different samples of the same species, more marked differences are to be found between different species and genera with respect to total nitrogen, ash, calcium and excess base. Excess-base content, which represents the amount of base available for neutralising soil acidity upon complete decomposition of the litter, is looked upon by investigators as a most interesting and useful index figure, which varied from 38.2 milligram equivalents per 100 grammes for a sample of pitch pine needles to 214.7 milligram equivalents for a sample of black walnut leaves.

This rapidly-accumulating evidence from other parts of the world provides a basis for interesting speculation concerning the genus Eucalyptus, and its effect on

soil development. The genus grows over such a wide range of soils and climate that any generalisations are likely to prove misleading, particularly as the percentage and chemical composition of the wood ash of different species is known to vary greatly, and a similar wide variation may be anticipated in leaf ash. If we regard Eucalyptus as coming within the general term "broad-leaved trees," we know from soil analysis and experiment that the European dictum[11] that broad-leaved trees require better soils than pines does not hold in Australia. Forest soils carrying magnificent forests reaching a height of over 250 feet, such as the Karri forest in the south-west of Western Australia, are too low in essential plant nutrients to support a stand of *Pinus radiata*, and other similar, if less striking, instances can be quoted. Whether the indigenous Eucalypt forest has contributed to the excessive leaching of these soils it is impossible to say in the absence of further research work. We know that, in the majority of Australian forest types, the process taking place under existing climatic conditions is in some respects not analogous to the podsolisation process described as applying to forest soils of northern Europe, owing to differences in class of leaf litter from indigenous forest trees and moisture relations arising from low summer rainfall.

A relationship between vegetation and soil type has long been recognised in Australia, and plant associations have been used as indicators of soil quality in extensive land classification surveys carried out in advance of subdivision in agricultural areas. Prescott,[12] in preparing a soil map of the continent, used vegetation maps to fix the boundaries of many of his major soil zones.

In dealing with the soils of Australia in relation to vegetation and climate, Prescott expresses the view that Eucalypts do not play an important part in determining the character of soil types comparable to the part played by deciduous trees of Europe and North America. This may be due, as he suggests, to quantity of annual leaf fall, or, possibly, the important factor may be found to be the quality or chemical composition of the leaf material.

The inferences to be drawn from studies published to date in the above connection appear to be (1) that the major soil groups of the Australian continent have been determined by climate with the modifications to be expected from exceptional parent material, (2) that certain species of trees are associated with certain soil zones but, as these zones largely coincide with rain belts, the controlling factor in tree distribution may be rainfall, (3) that, in so far as forest type is concerned, the main difference within the extensive habitat of the genus Eucalyptus is increased density of stocking and greater height-growth with increasing rainfall, and (4) that soils which appear to be out of harmony with existing environmental conditions of climate and vegetation may be fossil soils surviving from past geological age. An important example of this type is the ironstone gravel soil of the Jarrah forests of the Darling Ranges of the south-west of Western Australia, which Prescott describes as a fossil soil surviving from a tertiary humid cycle when swamp conditions probably prevailed in this region. It should be noted also that intra-zonal distribution of species is dependent frequently on geology and soil.

Despite lack of fundamental knowledge on these important issues, it is necessary to examine existing criteria and practice inherited from the traditional forestry methods of Europe and endeavour to sift the essential from the non-essential in terms

of Australian conditions. An essential feature of a forest is that the trees shall be grouped so that their foliage provides a more or less complete canopy. This serves two main purposes. One, which has no direct bearing on the subject of this paper, is to limit the development of side branches, thereby increasing the value and utility of timber produced. The second is to maintain shaded conditions on the floor of the forest to promote the development of humus and limit the growth of competing species. This raises the question of what is the most desirable type of humus for each forest type using the term "humus" in the forester's sense to cover leaf litter as well as organic matter in process of disintegration in the surface layers of the soil. Schlich[13] defines humus, as understood in silviculture, as all organic matter which, in contact with the soil, is gradually decomposed and forms in mixture with the upper layer of mineral substances the mould or black earth of the forest. He points out that there are different kinds of humus and briefly refers to mild or forest humus; dry mould formed by plants such as heather under dry conditions; and acid humus formed where there is an excess of water and a deficiency of air in the soil. Only mild forest humus is regarded as acting altogether favourably on forest vegetation. The presence of this class of humus is so constant a feature of well-managed forests in many parts of Europe that it has been accepted as a criterion of good forestry.

With the object of placing the terms used by pedologists examining forest soils on a more uniform and satisfactory basis, a committee of the International Society of Soil Science[14] recommended a few years ago that forest humus be described as "mull" or "mor." They defined mull as a mixture of organic and mineral soil material of crumbly or compact structure and without a sharp transition to the lower soil layers. Mor is defined as organic material usually more or less matted or compacted but sharply divided from the underlying mineral material. Mor is regarded as generally having two distinct layers, an *F*—or germination—layer made up of only partly-decomposed forest, litter and an *H*—or humified—layer, which is finely divided without recognisable structure. Although to date these unattractive terms have not been widely accepted by foresters, they do fill a need to describe varying conditions of the forest floor for which the use of the general term "humus" is not satisfactory.

An indication of the paramount importance placed in the past by European foresters on closed canopy as a measure necessary for normal and healthy growth of forests is the statement made repeatedly by Schlich[13] in his *Manual of Forestry* that, unless complete canopy is maintained, the soil is exposed to the effect of the sun and air currents, both of which act highly injuriously on the soil. Such a generalization makes strange reading to forests accustomed to working in Eucalypt forests in regions of low summer rainfall which cast little shade and in which mould or black earth never forms. It is reasonable to suppose that the importance of humus as opposed to leaf litter or dry mould in the forests of northern Europe is linked with comparatively limited supply of nitrogen available as plant food in the soils of that region. Busgen[11] claims that, in spite of the high total nitrogen content humose forest soil, the nitrogen available for the trees is often one of the soil nutrients present in the minimum, and the problem of timber yield is to a great extent a problem of the uninterrupted setting free of humus nitrogen by nitrification. He further points out that nitrification is stopped if the humus cover becomes much dried out. A single summer drought, which completely dries out the humus and

converts it into a "coaly" humus, is believed by some European investigators to make the nitrogen of the humus useless to tree roots and so bring tree growth to a stop for many years.

If these principles had application to many indigenous forests and plantations in Australia, where the leaf litter is completely dry for many months every year, a very inferior forest growth would be expected, but the contrary is the case in many such forests which are showing an annual volume increment very much higher than any European forest. Crowther[15] has pointed out that the organic matter must be related to the soil structure and the immediate effects of living or decayed roots may be of greater significance than those of a much larger amount of humified organic matter.

Teakle,[16] in a study of the nitrogen supply of an apple orchard in the south-west of western Australia for the purposes of comparison, examined samples of soil from adjacent virgin Eucalypt forest, pasture, and fallowed land over a twelve-month period. He found that, while the figures obtained by analysis for total nitrogen were low, the soils have a very considerable capacity for the production of nitrate nitrogen during the spring and summer months which is the period of active tree growth. In the virgin forest, Teakle found a minimum concentration of nitrate nitrogen was recorded throughout the year, and concluded that the virgin forest, with its undergrowth, had adapted itself to absorb practically all the available nitrogen, and maintains a minimum concentration in the soil.

Whatever may be the scientific explanation of the greater activity of nitrifying agencies in the soils of certain sub-tropical countries, the fact that nitrogen is the dominant fertiliser used in agriculture in northern Europe and superphosphate the dominant fertiliser in southern Australia has a direct bearing on silvicultural practice. Except in the case of pine species, which are dependent on mycorrhizal associations for healthy growth, and which will be dealt with later, the principal role of humus or leaf litter in the forests of southern Australia and similar climatic zones would appear to be the supply of plant ash as originally claimed by Liebig in 1840,[28] when he pointed out that farmyard manure was an effective fertiliser not because it was of like nature with the plant, which could use it as food on that account, but because the ashes of the plant contained essential minerals such as potassium, calcium, and magnesium. He did not use the word "ash" in its literal sense, but it would appear that our long hot dry summers do in fact lead to the decomposition of leaf litter so rapidly that it is open to question whether the chemical result in so far as soil fertiliser is concerned is very different from actual burning by a light running fire.

An examination of forest soil in Minnesota, U.S.A.,[2] which had been subjected to one severe fire, by Alwin and Rost in 1927, showed no significant change in chemical composition or physical properties below the surface layers of organic residues, even where this was entirely burnt off. They concluded that the lime, phosphoric acid and potash of the leaf mould would suffer no loss by burning and much would be left in a more available form.

Heyward and Barnette,[17] working in 1933 in the long-leaf pine region of the southern states of north America, where climate and forest type are more comparable to those of southern Australia, could find no evidence that soil nitrogen or organic matter were depleted in sections of the forest subjected to repeated ground fires over a

long period of years. Replaceable calcium averaged 36 per cent. more on burned than unburned sections, and they considered that the quantities of potassium, magnesium, phosphorus and other constituents of ash in the soil are somewhat increased by burning, but they are careful to point out that the physiological importance of the changes in chemical composition of the soil ascribable to fire is entirely unknown.[17] Certain physical differences such as permeability and moisture relationships between burned and unburned soils may more than offset differences in chemical properties. The same authors two years later published a further paper dealing with field characteristics of the humus layer of forest soils of the same region, and in this later study they state that complete fire protection for 8 to 12 years is necessary for the establishment of an approximate balance between accumulation and decomposition of the forest floor.

An examination of Jarrah forest protected from fire for a similar period shows the same marked improvement in the physical condition of the surface soil which, immediately under the thin layers of leaf litter, is loose and crumbly, offering an excellent cover and habitat for an active soil fauna and in a good condition to conserve moisture.

The accumulated evidence from many sources would seem to show that a very occasional fire may do no harm to the forest soil[2] in either temperate or sub tropical regions and that frequent fires have an adverse effect on the physical but not necessarily on the chemical properties of the surface soil. As opposed to this view, there is the fact that rosetting—a disorder of young pines in eastern Australia— is believed to be more likely to occur on certain soil types when the young pines are planted out within a few months of a heavy burn run through the area to clear up debris resulting from the clear-cutting of the indigenous Eucalypt forest. The "rosetted" pines can be restored to normal growth by spraying the foliage with a solution of zinc salts or by a heavy dressing of zinc applied to the soil, but with this latter method responses are much slower.

The use of controlled fire as a silvicultural or protective agency will seldom be found in practice to hinge on its direct effect on the soil. Expense in carrying out the work effectively and cumulative damage to regeneration and the boles and crowns of growing trees will be found to render uneconomical light burning on any extensive scale. Nevertheless fuller information concerning the effect of sunlight and wind currents on our soils and the story of humus assimilation may have an important influence on silvicultural systems to be adopted, mixture of species to be encouraged and regeneration methods to be followed.

The role of the forester in the tending of indigenous forests is to learn the essential requirements of the species of greatest commercial value and to provide optimum conditions for their growth. All forms of exploitation lead to changed conditions, which may favour or retard the regeneration and growth of the favoured species. Most foresters will agree with Trevor's statement[27] that, in the processes of natural regeneration, the art of silviculture reaches its zenith. The method of manipulating the mature crop to obtain the desired mixture of species and to control conditions of surface soil, shade and competition are without number and give unlimited scope for detailed observations and instinctive knowledge but, as in every other

branch of applied science, a solid foundation of scientific training is the surest method of avoiding mistakes.

The problems of the successful establishment of exotic plantations are in a somewhat different category. Nature may provide an occasional signpost, but there is no well-beaten trail to be followed, and success or failure must depend on accuracy of judgment of the forester responsible for selecting site and species. Two obvious indicators likely to prove of value to foresters in a new country have proved definitely misleading in southern Australia. The first of these is the height of the indigenous forest crop, and the second the growth of exotics as rows or clumps on farms, where soil profile and climatic conditions are similar to the proposed plantation site. A search for possible explanations of apparently contradictory results and study of remedial measures where errors of judgment have occurred have provided a large amount of valuable information concerning the requirements of the species concerned and the soils on which they have been planted.

Chemical analyses made of soils to which attention has been drawn by the disappointing growth of exotics have shown that many Eucalypts are capable of growing into first-class forests of great height, producing a large volume of timber per acre, on soils very low in plant nutrients. The extent to which this faculty is associated with special capacity on the part of the Eucalypt roots to penetrate deeply into the crevices of the rock material of the "C" horizon and obtain there essential mineral requirements remains to be determined.

Pines are regarded generally as having the majority of their feeding roots associated with mycorrhiza very near the surface. A recognition of the fact that all pines growing on improved farming land benefit from soil changes resulting from cultivation plus the artificial manuring of surrounding land or from the excreta of stock camping under them explains why their growth in such situations may prove misleading as a guide to behaviour in plantations established on land on which the indigneous Eucalypt crop has been chopped down and burnt immediately prior to planting.

The difficulty of ascertaining quantitatively the nutrients available to the plant by chemical analysis of soils makes the establishment of fixed standards of minimum requirements impossible by this method. Apart from a general indication of comparative fertility, individual chemical analyses of soils have little value. However, from a large number of analyses of soils within a limited climatic range on which the growth of a given species has been tested, the figures relating to certain elements may be found to have some index value within that range. For example, in the south-west of western Australia, it has been found[13] that it is not safe to plant *Pinus radiata* on virgin soils having a total P_2O_5 content of less than 300 parts per million, whereas *Pinus pinaster* in that same region will grow satisfactorily on virgin soils having a P_2O_5 content of 130 parts per million, and on soils of much lower P_2O_5 content, if given dressings of superphosphate. The work of H. F. Murphy[19] suggests that the value of total P_2O_5 content as a virgin soil fertility level indicator in this region may be due largely to the high percentage of silica and the low percentage of clays in these soils. Analyses of a few plantation soils in south Australia, although conforming

generally, have given some widely divergent results on heavier soils, thereby throwing doubt on the value of percentages of this element present as an index of fertility level in the soils of some parts of that State. In western Australia the total P_2O_5 content figure as an indicator breaks down when pines are planted on land which has been under pasture for a few years, in that the pines grow very successfully on soils with a much lower total P_2O_5 content than the minimum necessary in the case of virgin soils. More recent analytical work suggests that for any general scale intended to apply as a guide to the suitability of land which has been used partly or wholly cleared and used for grazing, as well as virgin forest soils, the available rather than the total P_2O_5 content may prove a more useful and reliable figure. The extent to which this may be due to artificial application or surface mobilisation of minerals by grass cover remains to be determined, but it would appear unlikely that the sparse crop of clovers and grasses produced in the early years of pasture establishment in western Australia is sufficient to render the second of these factors of great practical importance. Nevertheless the extraordinarily improved growth of pines planted on new or old pasture, however neglected its condition, is a most striking phenomenon.

The chemical analysis of plant tissue, whether wood, bark or leaves, has proved of little practical value as a guide to the proportionate mineral requirements of the plant. In only very few instances has any effort been made to correlate chemical analyses of soil types with ash analyses of trees growing on them. Pollinov,[14] working in the Black Sea region found, in the ash of hornbeam leaves, and concluded that apparently sufficient alumina was returned to the soil by the leaf fall to prevent the formation of the podsol soil type which might have been expected from the hypotheses of those who seek to interpret all soils in terms of climatic influences.

Other investigators who have tried to obtain a lead on nutrition problems by ash analyses of plant tissues[26] have found that the composition varies within very wide limits, presumably owing to varying soil conditions, and that the analytical results in so far as main nutrients are concerned have no reliable physiological significance, but may have some comparative value in the case of plants grown side by side under controlled conditions. Some workers dealing with deficiency diseases responding to treatment with minor elements have found a correlation between the quantity of such elements present in the plant, and the incidence of the disease.[20]

At the present stage of our knowledge detailed examination of the chemical composition of soils and plants is likely to have greater practical application in connection with intensive work in tree nurseries than large-scale plantation work, but, even in such cases, it is a highly involved investigation requiring specialised chemical training not only to make the analyses but also to interpret the results as, for example, the method published by S. A. Wilde and J. S. Kopitke[21] of determining the most economical rate of application of potash fertiliser to forest nursery soils based on the prior determination of the base exchange capacity of each nursery soil.

One noticeable feature of pine nurseries in southern Australia is the comparative rapid rate at which the nursery soils become exhausted and the falling off in the development of successive crops of seedlings after the nurseries have been in use for a period of years. When this depreciation takes place in a few years, the loss is serious, as clearing costs are heavy and old pastures which may be available without additional

clearing are seldom suitable on account of high cost of weed control. In a number of nurseries in western Australia, it has been found that soil fertility cannot be maintained by regular and heavy applications of standard fertilizer mixtures containing N.P. & K. Fertilizer test plots have not given any consistent results, although, on some sandy soils, stable manure heavily applied has resulted in greatly improved growth. In other nurseries neither stable manure, blood and bone, nor composts of various types have had any marked influence on growth. Examination of drainage conditions and determination of pH values have given no lead and further studies are necessary to determine the nature of the problem, which does not appear to respond to the application of growth-promoting substances in the form of ordinary fertilizers. No work has yet been done in the direction of testing the effect of applying growth-regulating substances of the auximone type, although there is reason to believe that they would particularly help the pine seedlings.

Before dealing with mycorrhiza as a possible explanation of these nursery growth problems, mention should be made of the apparently small influence on tree growth of the physical properties of the soil, except in so far as these affect drainage and the retention in the horizons of root penetration of essential plant nutrients. If drainage conditions are satisfactory, most forest trees appear capable of adapting their root systems to a very wide range of physical soil conditions. The availability of essential minerals in the soil is a much more important limiting factor than the percentage of sand or clay. It would also seem that most trees which grow in the Mediterranean type of climate are capable of withstanding severe drought conditions for a period of months each summer, during which the upper soil horizons, where many of their feeding roots are located, become completely dry and, in consequence, except when planted over rock or impenetrable layers at shallow depth, the reason for unsatisfactory growth of such tree species can seldom be accounted for by seasonal deficiency in soil moisture.

Detailed studies of form, distribution and functioning of tree roots might be expected to provide a great deal of valuable information on physiological problems of tree growth, if such studies were practicable. Opportunities for limited examination of root systems of large trees are provided from time to time by trees torn from the ground by wind action, and in loose and friable soils excavation of the root systems of young trees is possible. The difficulty of this undertaking, however, is well exemplified by some investigations made on the roots of *Pinus pinaster* three years after planting on deep coastal sands in western Australia. These 3-year-old pines had a well-branched root system which spread over a radius of nine feet and reached a depth of over eight feet. Even at this age odd lateral roots have been found to extend a distance of 21 feet.[22]

Although the popular view tends to associate certain species, it would appear that the form and distribution of tree root systems is determined mainly by soil and soil moisture conditions. In regions subject to lengthy drought periods each year, trees appear to develop a double root system with deep roots ramifying through the lower soil horizons which are permanently moist and a shallow root system distributed through the upper horizon, which is richer in organic material and possibly other plant nutrients.

In such cases, foresters have tended to look on the deeper roots as a source of essential water supply to keep transpiration going during dry periods when growth practically ceases. Veichmeyer[23] has demonstrated experimentally, however, that old crops of deciduous fruits may be produced in an orchard where the soil to the depth of several feet is kept at little above the wilting percentage during the greater part of the growing season. Breazeale[23] has carried this work further and shown by a most ingenious and interesting of pot culture experiments, using wheat and other cereals, that a plant may absorb water from any soil horizon where water is available, for example, a subsoil, and transport this moisture to another horizon where moisture is scarce, for example, the surface soil. It may there exude this water and in this way be enabled to dissolve and absorb certain amounts of nutrient materials from an otherwise dry surface soil. If this power is shared by trees—and there is no reason to believe that it is not—it may extend considerably the actively functioning periods of tree growth in countries of high temperatures and low summer rainfall, where soil moisture is the principal limiting factor in seasonal growth, and explain the very rapid increment shown by many species under such conditions.

Growth problems of pine nurseries and plantations are complicated by the mycorrhizal association between pine roots and fungi which must function satisfactorily for the healthy development of the pine crop. The western Australian Forest Department, when it sought, some twenty years ago, to establish pine nurseries in a territory without indigenous conifers, experienced serious difficulties which could not be overcome by summer watering or fertilizer treatments. In consequence, the department was one of the first forest services in any part of the world to recognise the complete dependence of pines on the association of their roots with a soil fungus and to inoculate artificially all new nurseries by the application of a dressing of soil taken from under a healthy pine stand. It was hoped that this discovery would solve the majority of our pine nursery and plantation problems. While it overcame one group of troubles, it was realised in a very short time that all irregular growth in pine nurseries and plantations could not be attributed directly to mycorrhizal disturbances and that the correction of unsatisfactory growth involved a very much wider field of investigation.

Young[24] working on fused needle disease of pine in Queensland, has made out a case for the hypothesis that some upset in the mycorrhizal equipment of the pine tree is responsible for this common condition of unthrifty exotic conifers in eastern Australia which has proved so baffling to research workers for many years past. He has had considerable success in restoring affected trees to normal growth by the application of phosphatic manures, which he suggests is mainly due to the fertilizer acting indirectly by stimulating the production of organic matter from roots and leaf litter of undergrowth species as well as from the pine crop, thus providing suitable organic material for the normal growth of the mycorrhizal fungi. When he offers the same explanation for numerous other types of irregular growth among pine species which do not suffer from fused needle, as well as those that do, he is leaving the realms of research for those of speculation. It is a curious circumstance that, despite the low organic and phosphate content of the soils of the south west of western Australia, examples of fused needle are extremely rare, although numerous other symptoms of dis-

ordered growth resulting from soil poverty may be found in many centres. This enigma awaits solution.

The success that has attended large-scale manurial treatment of western Australian plantations in promoting the growth of healthy pines on extremely poor soil types and restoring to normal growth stands which were planted on such sites originally without fertilizer has been due to careful soil mapping on the basis of the whole profile, both in experimental work and before general treatment, and to careful diagnosis and classification of disorders. From these studies it has been found possible to determine, within each region, the class of treatment likely to give the desired response either on a basis of soil type or abnormalities of growth in the case of plantations already established.

Treatments which have given results of commercial importance are cultivation of the site prior to planting, and subsequent intercultivation to control scrub, the application of dressings of superphosphate at time of planting, and subsequently at intervals of years until canopy is formed, and the application of zinc sprays to young pines suffering from a particular disorder known as "rosetting".

Particulars of these experiments and methods evolved from them have been published so that comment on a few outstanding features only is justified.

Cultivation on certain types of deep sandy soils is directed principally to the suppression of scrub competition, which otherwise would overwhelm the young pines. On other soil types, where scrub competition is apparently a less serious factor, both cultivation before planting and intercultivation between the pines may have a remarkable effect on the health and development of the pine crop.

Although capable of theoretical interpretation, it is a curious circumstance that the most marked responses to superphosphate applications to plantations of *Pinus pinaster* have been from the light dressing applied to the poorest sands. With improvement in soil type very much heavier dressings are necessary to secure corresponding results. Dressings of one or two hundredweights per acre of superhosphate applied to very infertile, deep and porous sands have resulted in satisfactory growth of *Pinus pinaster* being maintained for seven years or longer, although in practice it is considered economical to give dressings of one cwt. at intervals of three years up to the time canopy is formed.

Rosetting is a condition of *Pinus radiata* developing usually within two years of planting out, which is completely cured by one application of a weak solution of any zinc salt sprayed on the needles. Subsequent growth is dependent on the general factors of the locality, particularly the fertility of the soil. What function the zinc serves and the reasons for the failure of the plant temporarily to secure supplies are not known. One guess is that it may be due to the failure of the mycorrhizal fungus to become satisfactorily established following the transfer of the pine from the nursery to the plantation. Whatever may be the reason, the following figures supplied by the Government analyst, Perth, are of interest. Analyses of ash of pine needles showed that the zinc content of needles of healthy specimens of *Pinus radiata* varied between 10 and 19 parts per million. The ash of the needles of rosetted pines contained between one and five parts per million.

The corresponding figure for needles which had recovered from rosetting following spraying was from 5 to 9 parts per million. The ash of fructifications of mycorrhizal fungi, both Boletus sp. and Rhizopogon sp., contained between 30 and 40 parts per million.

In view of the fact that at least 35 elements have been detected[25] in the analysis of plant tissue, and the small amount of work done on the manurial treatment of forest crops, it is evident that we have still much to learn concerning measures which may lead to more even and rapid growth. Although carbon, hydrogen and oxygen make up approximately 95 per cent. of the dry weight of all plant tissue[25] and the amount of inorganic material per acre taken up by a tree crop is small and much of this is returned to the soil in the leaf fall, it is not a safe assumption in dealing with plantations on soil recognised as poor in agricultural practice to regard such soils as capable of supplying the whole of the mineral requirements of the tree. The development of a cheap mineral fertilizer has opened a new era in plantation practice, although foresters generally have been very slow to realise the possibilities of making use of such minerals to grow valuable crops of softwood on poor land in close proximity to large centres of population.

The determination of the manures to be used and the results to be achieved with various mixtures and rates of application requires patient experimenting following careful planning. Even then the forester is called upon to make difficult deductions, as it is never possible to await the marketing of the mature crop, which is the final test. The same difficulty obtains in deciding the silvicultural measures to be applied to indigenous forests. It is of great importance, therefore, that forestry students should receive a sound training in the basic sciences. Sudden enthusiasms for the fads or fashions of the moment and the acceptance of plausible generalisations have been the cause of many disappointments and much avoidable waste in Australian forestry in the past. No progress is possible without mistakes being made, but fundamental research by workers with specialised training can elucidate many of the questions of plant nutrition in its application to the forest crop on which we can only speculate today.

Essential knowledge is being slowly accumulated, and we are still relying chiefly on empirical methods. If we are to prove worthy of our heritage and restore the damage which has been caused to our forest estate by thoughtless clearing and burning, more adequate and efficient research methods are necessary. Many questions of national importance, including control of erosion, are involved, and these demand maximum efficiency in forestry practice. There is a clear and urgent case for attention by post-war governments to provide the funds for a large expansion in silvicultural research activities by highly trained scientists in every important forest region in Australia.

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FORESTRY IN WARTIME : LUXURY OR NECESSITY?

How important are forestry and foresters in time of war? Selective Service and the War Manpower Commission have answered that question in part by classifying forestry as an essential occupation and by providing for the deferment of certain students of forestry. The final answer depends on how successfully foresters themselves meet their responsibilities and take advantage of their opportunities to be of service in facilitating the output of forest products, in increasing the effectiveness of wood utilization, and in maintaining or even improving the productivity of the forests.

Last year the suddenly increased demand for wood for war purposes was met only by drawing heavily on accumulated stocks of lumber. This year production is falling off even more than had been anticipated, with serious shortages in prospect. As has been repeatedly pointed out, the chief bottlenecks are labour and equipment. Too frequently it is assumed that the only way to meet this situation is by getting more men, more tractors, and more trucks into the woods. Inadequate consideration has been given to the possibility of making more effective use of the men and equipment already available.

During the past quarter of a century nearly every major industry except lumbering has made conspicuous progress in pre-planning production processes and establishing production standards. Phenomenal increases in the production per worker and per machine have been the reward. While the problem in the lumber industry is somewhat different from that in most manufacturing industries in that its production environment is subject to more frequent change than is the case with the average mill or factory, this situation warrants rather more than less pre-planning in logging than in most other industries.

Foresters with the right background of training and experience can be of inestimable value in this field. One of the many services which they can perform is to plan the entire operation so as to use most efficiently the labor and machines that will be available. This involves determination by size classes of the timber which is now present and which should be removed; location of camps, main roads, and branch roads; selection of the most effective equipment; and decisions as to the standards of construction to be adopted for roads built to develop various volumes of timber, the loads to be carried on these roads, and the speeds to be maintained by transporting vehicles. After the operation is actually under way, it is essential to collect, analyze, interpret unit cost and production data with a view to making such adjustments as they may indicate to be desirable; to raise standards of performance through adequate local supervision of workers; and to establish piece-rate or bonus plans which will stimulate higher output and attract and keep the better type of worker so far as national wartime controls permit.

Professor D. M. Matthews,* who as consultant for the War Production Board has made an intensive study of the possibilities in these directions, estimates that with staffs which are properly organised and competently handled such activities can achieve the following results:

1. Increase the output of woods workers and the production of skidding and loading machinery up to 50 or more per cent.

2. Increase the production of trucks and other hauling equipment by 50 to 100 per cent.

3. Increase the production per set of tires by 100 per cent or more.

4. Effect a substantial decrease in over-all costs, including the cost of the extra supervisory personnel.

5. Improve the condition of cutover lands, with the possibility of earlier subsequent cuts and of continuous production from large ownership units.

Skeptics may discount these figures as being unduly high, but the possibilities of effecting marked economies in the use of men and machines through the effective planning, organization, and conduct of the logging operation remain impressive. These activities are distinctly within the province of the forester who is concerned with the production of timber for commercial purposes. Enabling workers and machines to turn out two board feet where they formerly turned out one is as much the task of the forester as growing two trees where one grew before. Fallers, buckers, tractor operators, and truck drivers are of course essential, but no more so than a supervisory staff which can utilize their services to best advantage. Anyone who thinks that the use of ablebodied forester in a professional capacity in time of war is unjustifiable overlooks the fact that in substantially increasing the production of a critical war material and in reducing the manpower and equipment needed for any given output, they are making a contribution of no mean proportions to the entire war effort.

The contributions which professional men can make in the field of wood technology are now so well recognised as to require little elaboration. Recent developments in making available new and approved wood products, and in economizing in the amounts of wood needed for specific purposes, have made clear the need for technical competence in the conduct of research in this field and in the application of its results. No informed person doubts that the wood technologist is contributing as much to the winning of the war in industry as he could in the armed forces.

Within the last few months various articles in the JOURNAL OF FORESTRY have illustrated the many directions in which progress is being made in the more efficient utilization of wood for a wide variety of purposes. To add just one more example, a recent visit of a few hours by a couple of wood technologists to a large aircraft factory made it possible for the management to decrease by some 25 per cent the size of containers used for overseas shipments, by 50 per cent the amount of wood consumed, and by 30 per cent the number of man-hours required for their construction. Multiply by several thousand these savings in a critical raw material, in manpower (not only at the factory but in the woods), and in priceless shipping space, and you begin to realize their significance.

Probably more difference of opinion exists as to whether measures aimed at improving, or even maintaining, the productivity of our forests constitute an essential activity in time of war. This is because of doubt as to their practicability, in view of other urgent demands for men and materials, and not because of any question as to their desirability. No one doubts that forests are one of our most basic resources, and that future demands for wood, as well as for other forest products and services, will require the maximum productivity of which they are capable. To reduce that productivity, unless such action is absolutely essential to the winning of the war, would

not only affect adversely the present wellbeing of the country but would constitute a distinct betrayal of trust toward those who will follow us.

Emphasis on improved practices is further justified by the fact that, if properly planned and integrated into the logging operation, they may often make for greater efficiency on the part of labor and equipment, and hence for increased output of urgently needed war materials.

In a recent address entitled "Soil Conservation Goes to War" Dr. Hugh Bennett, chief of the Soil Conservation Service, emphasized the necessity of meeting world demands for food in such a way as to avoid depletion of our soil resources. "It should be clear to all that people and nations cannot have a permanent agriculture without permanently productive soil and that permanently productive soil calls for adequate protection of the land against processes of soil exploitation and depletion. . . . Conservation is a wartime necessity contributing to the victory which all of us demand."

This is preeminently true of forestry. Foresters have an inescapable responsibility to make this fact clear and to participate in every possible way in facilitating increased output and wise use of essential forest products in such a way as to build up, or at the very least to maintain, the productivity of our forest resources. No magic is required for these achievements, but rather technical competence well fortified by imagination, ingenuity, and the will to succeed. Victory in war and in peace alike is often the reward of doing the impossible in many fields. Forestry must be one of these.—*Journal of Forestry*, Vol. 41, No. 5, dated May, 1943.

THE NUMBER OF SAMPLE TREES REQUIRED FOR DETERMINING VOLUMES OF WOODS WITH VARIOUS DEGREES OF ACCURACY

By Reginald Davey

Summary.—Little attention has been paid to the numbers of sample trees required for a given standard of accuracy. In order to investigate the question 422 trees from 16 plantations in the south of England were measured on the ground. These enabled the determination of the probable scatter of taper height.

The resulting statistics, combined with assumed errors of measurement of standing trees, provided an indication of the general magnitude of the maximum standard deviations likely to be found in practice.

The numbers of sample trees required for a 21 to 1 chance of a total volume within 6 per cent. and 8 per cent. of the true volume were determined for hardwoods and conifers.

Introduction.—Large woods are generally measured by the method of the 'Mean Basal Area Tree.' It has become established by long usage, in spite of adverse criticism [(1) 55]. In its simplest form it consists of measuring and tabulating the breast-height girths of all the trees in the wood, and calculating the total basal area. This, divided by the number of trees, gives the basal area of the average tree, the quarter girth of which is looked up in tables. A number, usually 20, trees possessing this girth are measured standing, and their average volume taken as that of the mean volume tree. A number of refinements, by dividing the trees into groups, have been introduced from time to time. These aim at increasing the accuracy of the estimate. The me-

thod of selecting the sample trees has also been considered, resulting in two modifications of the principle of the random sample. The Forestry Commission research staff select as sample trees those that appear typical of the stand [(2) 10 and (3) 124]. The difficulty of choosing trees possessing mean values led Chaturvedi to propose the selection of an equal number of maximum and minimum trees [(1) 42]. Neither of these methods enable a determination of the probable accuracy of the resulting volume. In the case of a random sample, in which the trees are selected by a purely mechanical method, both the probable accuracy of the result and the number of trees required for a given standard of accuracy can be determined. The calculations are the same, whether the mean basal area tree method is used or the new system of separate means proposed by Chaturvedi [(1) 59], and developed elsewhere (4) for commercial measurement. Sampling errors are due primarily to the scatter of the various dimensions of individual trees about the mean. The ordinary process of measuring standing trees introduces a secondary source of error, which can with care be kept within modest limits.

Errors of measurement (based on assumptions and not on calculated statistics).—The breast-height girth of each sample tree is measured with a tape. The liability to error is small, compared with height and taper, and it can safely be neglected. If an instrument is used for tall trees, it may be considered reasonable to anticipate an accuracy of 5 per cent when measuring the height of a growing tree. This means that a 40-foot hardwood is measured within a foot twice in every three trials, and within two feet 21 times in 22 trials. An 80-foot conifer requires measuring within 2 and 4 feet respectively in the same numbers of trials. This is expressed as follows:

Standard error of measuring height = $\pm$ 2.5 per cent.

Height can be measured, but taper must be estimated. For this reason an accuracy of 10 per cent is proposed.

Standard error of estimating taper = $\pm$ 5.0 per cent.

The influence of the new taper tables (4) on the accuracy of estimation can be judged only after trial by different persons under varying conditions.

Both these errors of measurement are present in the resulting volume, and they are combined by the formula for the standard error of a product.

Standard error of determining the volume of a growing tree = $\pm$ 5.6 per cent.

This represents the assumed error due to measuring a tree standing. It does not arise in the case of felled trees. It is additional to errors of sampling due to the scatter of the individual measurements.

Scatter of Taper × Height.—

Height and taper are multiplied together in order to obtain the volume. The error due to their respective dispersions can be determined separately for each, and then combined by the formula for the standard error of a product. Alternatively the taper × height of each stand may be considered. Both methods yield the same result.

In order to obtain an indication of the general magnitudes involved the following trees were measured on the ground from plantations in Sussex and Oxfordshire: 162 hardwoods; 141 conifers, over 8 inches quarter girth, at 5 ft; 119 conifers, under $8\frac{1}{4}$ inches.

The standard deviation of the taper × height of each sample was determined and expressed as a percentage of the mean. The standard deviation of the standard deviations was also calculated. The following statistics emerged.

STANDARD DEVIATION OF TAPER × HEIGHT

Description	No. of Stands	*Standard deviation, per cent of mean*	*Maximum value*
Hardwoods	6	± 18 per cent. ± 3·6	25 per cent,
Conifers, over 8″	7	15 per cent. ± 2·4	20 per cent.
,, under 8¼″	3	18 per cent. ± 2·9	24 per cent.

The maximum value of the standard deviation likely to be found in practice is taken as the standard deviation of the means plus twice the standard deviation of the standard deviations. There is on the basis of the present data, a 21 to 1 chance that it will not be exceeded. When trees are measured standing, the standard deviations are increased by the errors of measurement. These are represented by a standard error of 5.6 per cent. (see previous section). Using the formula for the standard error of a product, the standard deviations of taper × height assume the following values.

STANDARD DEVIATION OF TAPER × HEIGHT OF SAMPLE TREES MEASURED STANDING

Description	*No. of stands*	*Standard deviation, per cent of mean*	*Maximum value*
Hardwoods	6	± 19 per cent. ± 3·8	± 26½ per cent.
Conifers, over 8″	7	16 per cent. ± 2·6	21 per cent.
,, under 8¼″	3	19 per cent. ± 3·1	25 per cent.

Substituting the maximum values of the standard deviation in the formula for the standard error of a mean provides the number of standing sample trees required for a given accuracy.

NUMBER OF SAMPLE TREES, MEASURED STANDING, REQUIRED TO DETERMINE THE TOTAL VOLUME OF A WOOD WITHIN THE FOLLOWING DEGREES OF ACCURACY

	Probable accuracy	
	21 : 1 chance of 6 per cent.	21 : 1 chance of 8 per cent.
Hardwoods	78	44
Conifers, over 8″	49	28
,, under 8¼″	76	39

This table provides for the maximum scatter of the values that the data indicates as probable, on the basis of a 21 to 1 chance. In the majority of cases the numbers of trees indicated can be relied upon to yield a higher degree of accuracy, provided care is bestowed upon the measurement.

In this connection it is interesting to consider the probable accuracy of the volume based on a sample of 20 trees measured in each of the 18 stands, 16 of which were used for the purposes of these calculations.

PROBABLE ACCURACY

(21 : 1 *chance*)	*No. of stands.*
5 per cent.	2
6 „	4
7 „	5
8 „	3
9 „	2
10 „	1
11 „	1
	18

The trees were measured on the ground, so that no account is taken of the error in measuring growing trees.

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PHILOSOPHY IN FORESTRY

BY E. A. GARLAND

My dictionary, an intimidating tome, defines philosophy as the knowledge of the causes of all phenomena both of mind and matter. I gather, however, that specialists in this pursuit are content, more modestly, to regard it not as a seeking to know more but as a seeking to know better, to know more clearly what is known already. Sir James Jeans[1] has pointed out that in early European philosophy, which was almost exclusively Greek, a philosopher was any man who, like others in having had far less opportunity than modern philosophers to acquire a background of scientific knowledge, could nevertheless look beyond the narrow groove in which his daily work lay and steer his way through life by availing himself of such wisdom as had then accumulated: a little knowledge mixed copiously with speculative conclusions drawn from this knowledge by contemplation, abstract reasoning and discussion. Bertrand Russell has also expanded the definition of philosophy as follows: "Man on his own account is not the true subject-matter of philosophy. What concerns philosophy is the universe as a whole; man demands consideration solely as the instrument by means of which we acquired knowledge of the universe. We are not in a mood proper to philosophy so long a we are interested in the world only as it affects human beings; the philosophic spirit demands an interest in the world for its own sake." The philosophy of any science has been described[2] as "the reflective analysis and critical comparison of its fundamental concepts." Thus, even though our knowledge may still be copiously mixed with speculative conclusions, we can justify with the renowned title of philosophy a discussion and critical examination of the fundamental concepts of forestry. If a forester has not ample time for reflective analysis and contemplation there is something wrong, either with the man or his job. Such discussion may also reasonably be preceded by some brief consideration of the manner in which man is the instrument through which the science of forestry plays its present part in the world.

It is clear that man's ingrained prejudices and bias, accumulated through untold centuries from his first beginnings in thought, must exert large influences on his mental processes and consequently on the way he looks at the problems which confront him in his efforts to adjust himself to the world in which he lives. Just because such bias is entirely instinctive and unconscious there is great need to make special efforts to understand and counterbalance its effects. Of all man's problems in adjustment the earliest, as well as the most persistent and essential, is without doubt his unceasing one with, or against, the world's vegetation. Major changes in the world's climate and consequently in its vegetation, were responsible for the most important events in man's early existence, by forcing migrations. In fact the most important migration of all for man must have been of this sort: when his most remote ancestors changed their arboreal existence. Julian Huxley in an essay on the *Uniqueness of Man*, has emphasised the point that of all animals only one group, an offshoot of the higher primates which had be-

[1] *Physics and Philosophy*: Sir James Jeans (Cambridge University Press 1942).
[2] *Reality and Value*: A. Campbell Gainell (George Allen and Unwin Ltd., London. 1937).

A

come terrestrial after a long period of arboreal life, could possibly have developed the peculiar characteristics which man, alone out of all animals, possesses. It must have been a thinning of the primeval vegetation which led gradually to the great change from living in trees to becoming hunters on the ground and thus more carnivorous. Whether the further developments in man's progress were first as cultivators of crops and later as pastoralists guarding flocks and herds, or whether the opposite sequence was followed, or both grew up practically simultaneously, can probably not be definitely decided. In any case what is of more importance to present considerations is that there are ample reasons to believe that since then several slow movements of belts of vegetation, corresponding to similar movements of belts of climate, certainly occurred. Thus even before man himself began to set up changes in vegetation, which he was unable to control because of lack of proper understanding of the ways in which he had caused them, similar changes were periodically taking place without any initiative on his part. These gradually made his accustomed existence impossible and forced him to move elsewhere. It seems in fact reasonable to risk a broad generalisation and state that, throughout his whole existence, man has been faced with major crises in his modes of life from time to time, in the form of struggles against vegetation which was either too dense, tall and wet, or too thin and dry. There might be an intensely interesting study in research into the history of different races in this respect, as recorded in their mythologies. Where forests were scarce and becoming more rare, the gods gradually became enshrined in sacred groves. Where forests were in excess and spreading, they were peopled with spooks, evil spirits and all sorts of predatory beasts of the imagination, which made their dark recesses more gloomy and sinister. All of this suggests a bias in man, gradually accumulated through untold centuries and consequently inherent and unconscious, to treat trees in bulk as something apart from his main agricultural or pastoral occupations. The very late development of forestry may be a proof of this and it is certainly strange that, considering the importance of timber as a raw material, we should have given so very much more labour and devotion to the development of every other vegetative product, even including the fruits of several trees, such as walnut, mulberry, apple, cherry and others, which also produce excellent timber. Classification is, as Julian Huxley has pointed out,[3] the first and most obvious characteristic of man, because to have words for objects implies the faculty of recognising objects as members of a class: thus providing the potential basis for a concept. This potentiality the use of words transformed into activities: words being the tools which carve concepts out of experience. Therein lies the great danger that these clumsy tools are treated as instruments of precision and classifications once made are regarded as final. Because something was labelled Peace, we have believed it to be so. Because something was labelled Politics, or Religion, we were content to consider it as a class entirely remote from other concepts labelled Everyday Life and the Common Man. Tradition has in this way separated Forestry from Agriculture as an activity of a different class. Why? With what real justification? I suggest that it is high time to examine this classification critically and try to decide, in the light of the most recent discoveries of science, whether this separation is sound or unsound and in need of revision.

(To be continued.)

[3] *The Uniqueness of Man*: Julian Huxley (originally published in *Yale Review*).

SAND-CLAY ROADS

BY S. N. KESARCODI

In 1938 the Government of Bombay appointed a committee of experts to investigate the question of constructing cheap and durable roads. The Committee's report was published in 1941, and the following is a description of the type of inexpensive road construction which in the view of the Committee holds out great promise. The advocate of this type of road (Mr. U. N. Mahida, I.S.E.) calls it *stabilised earth road* or *sand-clay road*.

Without going into the intricacies of soil physics, it may be stated as a practical guiding principle that all soil mixtures commonly used for road surfaces are highly stable at some moisture content. The moisture which binds soil mixtures into masses stable enough to withstand the abrasion produced by traffic must have surface tension greater than that of free water. The practical application of this principle merely involves a proper mixture of sandy and clayey soils to obtain the best results.

The materials necessary in the construction of Sand-clay roads are: sand, silt and clay, not as defined in the International Soil classification but as under:

Sand—Material possessing neither capillarity nor cohesion in appreciable amount (particles larger than 0.05 m.m. diameter).

Silt—Material possessing appreciable capillarity but as cohesion (particles between .05 and .005 mm. diameter).

Clay—Material possessing capillarity and cohesiveness (particles less than .005 mm. diameter).

The best proportion for the surface crust is 30 per cent. clay and 70 per cent. sand-*cum*-silt. A 6 in. deep crust on ordinary earth or murrum formation is ample for village roads. Haphazard mixing of the materials will not yield good results. The following tests will be useful in the field:

Test 1—To find out the proportion of sand in the soil, take a sample of dry soil, say, 10 *tolas*, mix it in a tumblerful of water and pour off the water. Continue the process till sand remains in the tumbler. Dry the sand and weigh it.

Test 2—If the poured off water is kept in another vessel, the silt in it will settle quickly while the clay will remain in suspension. Pouring off the turbid water will leave behind wet silt.

Test 3—To test the quality of clay, make balls of the various samples and place them in water. The ball which holds its shape longest is the best clay.

Defective proportioning of the mixture is immediately noticed by the appearance and behaviour of the crust under consolidation with a light roller. If the surface appears muddy, deficiency of sand is indicated. Refusal to bind shows that the clay portion is insufficient.

Subsequent maintenance merely consists of properly reshaping the surface. Local potholes and cuts may be repaired by adding sand-clay mixture or either sand or clay as may be appropriate.

The above type of construction is still in an experimental stage and has stood well under moderately heavy mixed traffic of bullock carts and buses and seems well adapted for village approach roads but perhaps not for heavy forest traffic. It may, however, be found useful for roads mainly meant for inspection and on which additional light bullock cart traffic could be permitted.

THE GOHNA LAKE AND TROUT FISHERY

By J. D. KHANDURI,

(Range Forest Officer, Dhanpur Range.)

Gohna, from which the lake derives its name, is a small village, latitude 30° 22′ 18″ North and longitude 79° 31′ 40″ East in the Himalayas (Himanchal), situated in the north-west of British Garhwal, U.P., on the right bank of the Birahi Ganga, a tributary of the Alaknanda river. The latter, after its junction with the Bhagirathi, at Deoprayag, 62 miles above Hardwar, is thenceforth known as the river Ganges. Hardwar, the well-known sacred bathing place, is situated at a gap in the Siwaliks through which the Ganges after passing out of the Himalayas, debouches on to the plains of northern India. The distance from Gohna to Hardwar along the river valleys is about 150 miles. The map in *Plate No.* 2 shows the important places.

The lake was formed by a huge slip from Maithan hill, close to Gohna village, in September, 1893 which, damming the Birahi Ganga, held back its waters for about two miles in the beginning.

The fall was estimated to contain 12,500,000 cubic feet of rock. It was catastrophic in its magnitude and continued for three days with deafening noise and clouds of dust which darkened the neighbourhood and fell for miles around, whitening the ground and trees like snow. Great lumps of rock weighing many tons were catapulted through the air, striking far up on the slopes of the opposite side of the valley.

The huge mass of water thus impounded in the lake so formed escaped after 11 months and three days, eroding through the dam and causing a severe flood in the Alaknanda valley; but due to prompt and timely action by the authorities, the only loss of life in the vicinity of the slip was that of a *faqir*, known as the Gohna *faqir*, his wife and three children who persisted in remaining by the side of the slip in spite of being forcibly removed twice from the danger zone. There was, however, great loss of, and damage to, public and private property in the valley below the dam

The lake permanently formed after the flood contains now the finest trout in India and is available for trout fishing.

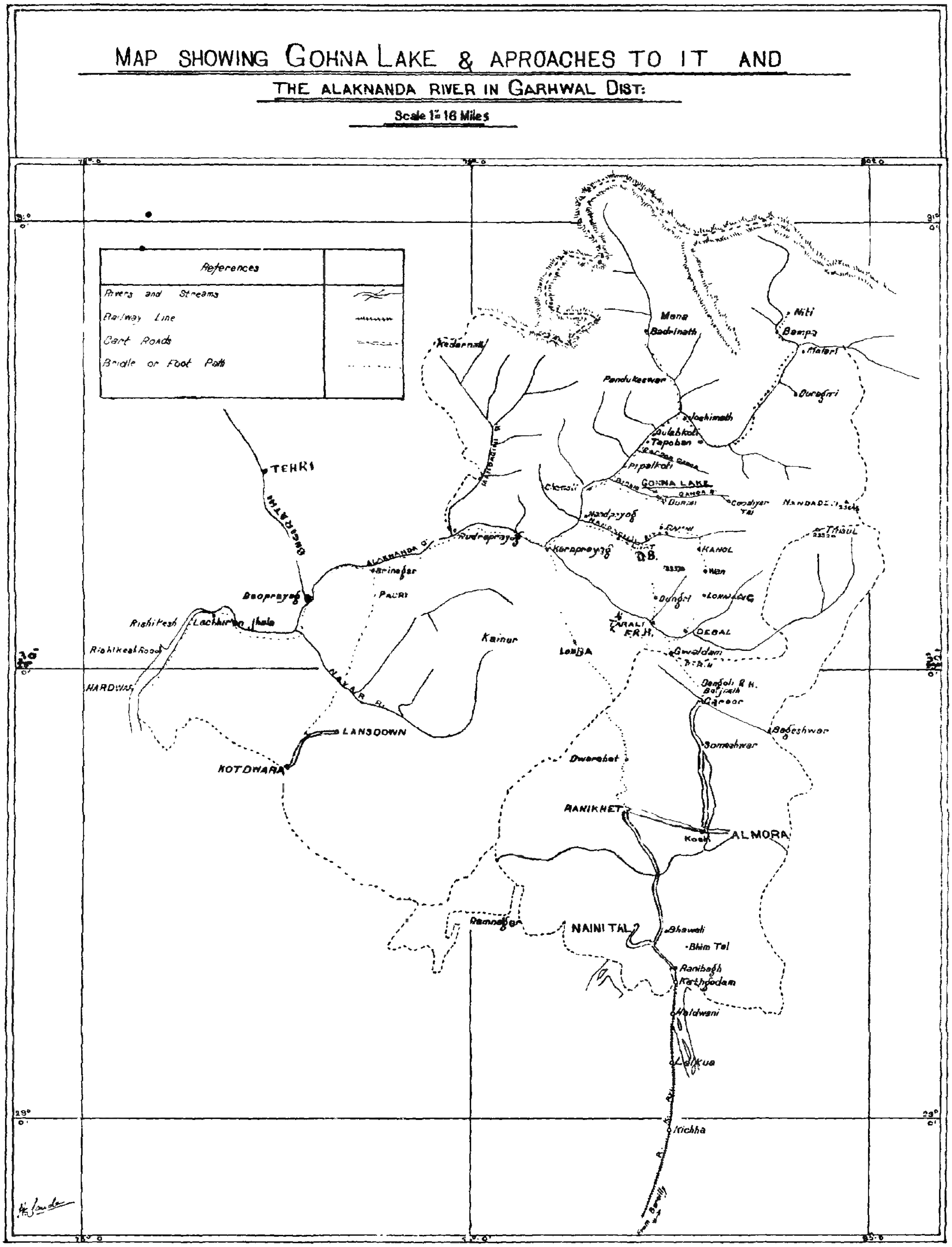
For the sake of convenience and interest the subject will be dealt with in two sections – I. *History of the lake*; and II. *Trout Fishery of the lake*.

HISTORY OF THE LAKE

First information report of the slip.—It was by the end of September, 1893, when the District Officer of Garhwal received intimation from the *patwari* (local revenue officer) of the locality that a rock slip of some magnitude had occurred in the valley of the Birahi Ganga near the village of Gohna.

The site of the slip was somewhat inaccessible and off the regular line of the pilgrim route; hence accurate information concerning it was not available for some time and the importance of the event was not fully recognised. Towards the end of October, 1893, owing probaby to heavy rainfall which occurred at that time throughout Kumaon and Garhwal, a further slip took place on the site of that already reported. On the 1st November, 1893, a more circumstantial (though still inaccurate) report of what had happened was submitted to the District Officer by Pt. Hari Kishan Pant, the District P.W.D. Officer who, while accompanying the Executive Engineer of Kumaon, on a tour of inspection, had seen from a distance the slip and the lake, already some two miles long. Although so far none of the reports received by the Deputy Commissioner of Garhwal had emphasized the abnormal dimensions of the slip which had taken place or the mass of water which was banking up, sufficient information had been furnished to show that a very serious state of affairs had arisen.

Action taken by the civil authorities.—In view of the dangerous situation the Deputy Commissioner, Garhwal, submitted a report to the Commissioner, Kumaon, suggesting that the Government should be moved to


MAP SHOWING GOHNA LAKE & APROACHES TO IT AND
THE ALAKNANDA RIVER IN GARHWAL DIST:
Scale 1"=16 Miles
References
Rivers and Streams
Railway Line
Cart Roads
Bridle or Foot Path
TEHRI
Kedarnath
Mana
Badrinath
Niti
Bampa
Pandukeswar
Joshimath
Tapoban
Pipalkoti
GOHNA LAKE
Chamoli
Nandprayag
Karnprayag
Rudraprayag
Srinagar
Deoprayag
PAURI
Rishikesh
Lachhman Jhula
Rishikesh Road
HARDWAR
Kainur
LANSDOWN
KOTDWARA
NANDADEVI
TRISUL
KANOL
DEBAL
Gwaldam
Bageshwar
Someshwar
Dwarahat
RANIKHET
ALMORA
Kosi
NAINI TAL
Bhowali
Bhim Tal
Ranibagh
Kathgodam
Haldwani
Lalkua
Kichha
Ramnagar
From Bareilly

take immediate steps to have a local inspection carried out by two or three experts. Accordingly the Commissioner of Kumaon submitted the whole matter to the Government on 15th November, 1893, with the request that the slip be examined by a competent engineer as early as possible.

Orders by Government.—Immediately on receipt of the report from the Commissioner, Kumaon division, the secretary to Government issued orders to Colonel Pulford, R.E., superintending engineer, who, with 24 years of service, had a deservedly high reputation for professional skill, readiness of resource, general ability and energy, to proceed to the scene of the slip with all possible despatch, to submit a description of the obstruction, and to report on the measures to be adopted to prevent the loss of life and destruction of property which might follow on the sudden release of the accumulated waters.

Inspection of the scene of occurrence by the Superintending Engineer.—Colonel Pulford, R.E., superintending engineer, 2nd circle, received the orders of the Chief Engineer on the 19th November, 1893. The locality to be visited was in the interior of Garhwal, some 130 miles to the north of Naini Tal, where there are difficulties of transport, foodstuffs, etc. Hence he had to make arrangements for a complete outfit of all kinds of ordinary necessaries and so it was not until the 28th November, 1893, that he could start for the scene of the catastrophe. He arrived at Gohna on the 12th December, 1893, and spent the following day carefully examining the various portions of the slip and specially the large and deeply marked gullies which the heavy rain of October, 1893, had cut into the downstream face of the dam.

On the next day (14th December, 1893), he deputed Mr. Wildblood, the District Engineer of Almora, and Pt. Hari Kishan Pant, the district surveyor of Garhwal, who had accompanied him in this tour, to make a rough survey of the lake and the tributary streams by which it was fed and to collect all available technical data from which to calculate the amount of water passing into the lake at different times of the year. On the basis of the figures collected and maps of dam and lake, he was able to prepare an estimate of the rate at which the lake level was likely to rise and as a result forecast the approximate date on which a flood might be expected.

On the data thus collected Colonel Pulford despatched a telegraphic report to the Chief Engineer and secretary to Government, *via* Pauri, the nearest telegraph office, distant 60 miles or about four days' march from Gohna, in which he gave a summary of the position and possible dangers.

The slip and the dam formed by it represented a terrific sight and were probably the greatest of the kind ever known. Those who have seen Naini Tal (U.P.) can roughly imagine the size of the slip and dam which would have filled up the entire valley of Naini Tal from China at one end to the Sulphur Springs at the other, and up to a level of the government house (*vide Fig. III, Plate 3*).

The report of the Superintending Engineer shows that the slip fell from the side of a precipitous hill close to the river on its right bank. This hill had an elevation of about 9,000 feet above sea level and the summit was about 4,000 feet above the bed of the stream. The slip took place from the very top of this hill and left an almost perpendicular face to the hillside for the entire length of the slip. The first slip took place on the 22nd September, 1893 and, during the heavy rain of October, 1893, some further slips occurred: but the main slip was that of the 22nd September, 1893. The force of the fall from so great a height as 4,000 feet carried the rocks and débris from the right bank right across the river-bed and half way up the steep hill on the left bank; then, its energy expended, the mass slipped down again into the bed of the river, forming a dam and a big slope up against the hill on the left bank. The consequence was that it appeared as though a portion of the dam had been formed by a big slip from the steeply-scraped hill on the left bank. The further slips of October, 1893, piled up the dam on the right bank against the hill on that side, so that the top of the dam had a large depression in the centre

some 150 feet or more below two sloping mounds of rocks and débris. The dam itself was a very massive affair. It was largely composed of enormous masses of rock—some of which were calculated to be more than 1,000 tons in weight. There was, in addition, a very large admixture of detritus and broken rock and a thick layer of impalpable powder, which gave the whole place the look of being covered with white clay-dust. The rains of October, 1893, had scoured out deep gullies in the powdery layer over the outer slope of the dam.

With regard to the heading-up of the water, the dam was estimated to be roughly 900 feet high, 2,000 feet across at top, 11,000 feet at base along the valley, 3,000 feet at top and 600 feet at bottom across the valley. The bed of the river slopes at about 250 feet in the mile or about one in 20, and from these data the depth of the lake formed was considered to be 450 feet on 14th December, 1893, and, that, with a further rise of some 350 feet, the water-level would reach the top of the dam.

The rate of the rise of water in the lake was then eight inches per day and 260 c. ft. of water per second was running into the lake. On the preliminary data it was first calculated that the water would top the dam sometime in the middle of the following May: but in a subsequent calculation during April, 1894, on the basis of further and more accurate data collected by Public Works Department officers at Gohna, a more reliable forecast of flood was made to be between the 15th August, 1894, and the end of that month. This eventually proved to be correct as the water actually topped the dam on August 25, 1894.

Forecast of the Catastrophe.—It is never possible for future events to be predicted exactly. However, with the scientific and skilled knowledge of the experts it was presumed that the impounded water, on topping the dam, would necessarily rush out very vigorously and at least 250 feet or so of the dam at the top would gradually be carved away. And after that the main portion of the dam might get thoroughly jammed and consolidated together so as to form a permanent lake with a natural outfall over the big rocks forming the dam. A terrific flood was, therefore, anticipated as, considering the size of the dam and lake, it was practically impossible to do anything to let off water artificially under control by cutting channels or constructing weirs with a system of falls and shoots, as they would require prohibitive sums and great time. The only thing, therefore, that was possible then was to insure against loss of life and reduce the damage to Government and private property to the minimum when the water would escape down the valley from the lake.

Cause of the slip.—There are various causes of the slip. The following is an interesting although rather technical account of the causes of the slip.

"The fall of the Maithana hill was attributed to several causes. The dip of the dolomite rock of which the hill is composed was the primary cause. The beds of the rock are inclined at an angle of about 45° to 50°. As the dip of the rock on the northern side of the Gohna valley is greater than the angle of repose of dolomite, sliding tends to take place when the necessary facilities are presented. As long as the slope of the surface of a mountain does not exceed in average angle the dip of its strata there is no danger of a slip. In this case, the foot of the slope was undermined by the action of the river and springs. Thus the average angle of the slope was increased and an enormous fall resulted. It is perhaps as well to mention that if rock beds are well cemented and subject only to the influence of their own weight, the surface slope may greatly exceed the dip before sliding commences. In the land slip at Gohna, however, not only was the support removed by undermining at the foot of the slope and loosening of the beds, but the beds were impelled outwards by a series of changes following as a natural consequence of the process which destroyed the originally compact nature of the strata. The causes combined to precipitate a mass of material which

dammed the Birahi Ganga and formed the Gohna Lake (*vide Figs. I & II, Plate* 3).

The causes producing a loosening of the strata were rainfall and melting snow, which resulted in a reduction of the coefficient of friction."

Previous Floods.—Twenty-five years before the Gohna flood, there had been two heavy floods with horrible results in the Alaknanda valley, known as Goodyar Tal and Garoor Ganga floods, which washed away many human and animal lives and much property. Before proceeding further about the Gohna lake it might be of some interest to give some details of the previous two floods in 1868 in the Birahi Ganga and Garoor Ganga valleys as mentioned above. Both these streams are the tributaries of the Alaknanda river.

Goodyar Tal Floods.—On the night of 18th June, 1868, a heavy flood was caused in the valley of the Birahi Ganga, some eight or nine miles higher up the valley of the Gohna lake, by a heavy land slip falling into the lake. The lake was called "Goodyar Tal" and had been in existence for many years. The land slip fell into the lake and the entire basin was filled up. The accumulated water forced its way over the dam which held it up, down into the bed of the stream. The results of the flood were very disastrous. Seventy-five persons or even more were drowned: most of them were pilgrims encamped at Chamoli *en route* to Badrinath, and a flock of 800 sheep encamped on the bank of the Birahi Ganga was destroyed. The loss of property due to this flood was valued at several thousands of rupees. The bridge and houses at Chamoli and the lower parts of Nandprayag and Srinagar *bazaars* and a large portion of the road were washed away. In short, severe damage to property and loss of life was caused by this flood as none had any knowledge of this flood beforehand. Hence there was no warning and only a few—probably awake by noise—at once ran up the bank and escaped: all the others with the houses were swept away within the flood zone.

Garoor Ganga Flood.—After about 1½ months, another flood came down on 3rd August, 1868, from Garoor Ganga, which falls into the Alaknanda about eight miles up from the junction of the Birahi Ganga with it. It also caused destruction of life and property, though not on so great a degree as before (Goodyar Tal flood). As far as information was available, it was revealed that 16 pilgrims were washed away while sleeping in a rest-house on the bank of the Garoor Ganga, In Pakki and Tangni, on both sides of the Garoor Ganga, some houses were destroyed and two persons were drowned, while at Pipalkoti, which is about four miles below it, a bank fell in and crushed three others. The fall of rain which caused this flood was attributed to have been of the nature of a watersprout, as the whole hillside had sunk about ten feet, and a large land slip blocked up the river for a time.

Precautionary measures against Gohna flood.—Bearing the consequences of previous floods in mind, the authorities had a very anxious time before them. Hence they started at once taking all possible precautionary measures to combat with the magnitude of the coming catastrophe. The main objects of the measures were:

(i) To prevent loss of life, and

(*ii*) To save as much public and private property as possible.

To achieve success in the abovementioned objects, the following measures were adopted, for which a sum of Rs. 69,000 was sanctioned by Government:

(*i*) Construction of bench marks on the slope of the dam to observe rise of water in the lake.

(ii) Running a telegraph line from Hardwar to Gohna to at once intimate the state of affairs at Gohna.

(*iii*) Arrangements to dismantle suspension bridges over the Alaknanda river.

(*iv*) Diversions in the pilgrim road.

It was further arranged that the engineering department would erect masonry pillars at proper intervals along the valley line to show the possible safe limit from flood, so that civil functionaries could keep all persons and cattle above the safety level when warn

ing telegrams of the flood were received from Gohna.

By the end of March, 1894, considerable progress was made in carrying out the protective measures which had been sanctioned by government.

Bench Marks.—Masonry bench marks were constructed at 10 feet intervals down the slope of the dam. They were numbered and the P.W.D. officer stationed at Gohna was required to send telegraphic reports every week to higher authorities saying exactly where the lake level had reached.

Telegraph line opened.—A telegraph line was run from Hardwar right up to Gohna, opening the intermediate offices gradually in the whole line at important places, mostly at junctions or *prayags*. Telegraphic communication was completed in Gohna by the 12th April, 1894.

Survey and observation at Gohna.—Lieutenant Crookshank, R.E., was posted to Gohna in charge of survey and observations of the lake. Weekly telegraphic reports of the rise of the water in the lake were sent regularly to the Chief Engineer, roads and buildings and irrigation and all other officers concerned, as well as to the manager, Oudh and Rohilkhand Railway (now E.I.R.), Moradabad.

Suspension bridges removed.—In regard to Government property, suspension bridges below Gohna over the Alaknanda river down to Lachmanjhula were removed gradually and replaced by temporary *jhulas* (rope bridges) of manila ropes.

Diversion in roads.—In the pilgrim road to the holy shrines of Kedarnath and Badrinath diversions were made from the danger zone specially from Byasghat to Rudraprayag and Gopeshwar to Hat, etc. through the interior.

Signal pillars.—Masonry signal pillars, at the rate of 2 per mile were erected along the valley between Gohna and Hardwar. These pillars were 4 ft. × 4 ft × 6 ft. high and were placed 200 feet above ordinary high flood mark for the valley above Srinagar and 100 feet above the ordinary high flood mark below Srinagar.

Notice to the people along the valley.—Arrangements were made to give notice to the people along the valley to remove their moveable property to places of safety above the flood limits before the actual catastrophe took place, which would depend upon the observations at Gohna; and for the P.W.D. Officer stationed at Gohna to give a timely warning to all the stations along the valley. Arrangements were also made to light beacons on commanding places along the valley should the flood occur during the night so that the people concerned might know of the catastrophe.

Criticism in the press.—While work in every department was proceeding vigorously along the line, various points in connection with the operations were made the subject of discussion and criticism in the public papers. The chief question taken up was the advisability of cutting a channel through the dam to allow the water to run off before the level of the lake reached the full height of the dam. The telegraph line was remarked to have been erected at enormous expenses to apprise the people in the path of flood of the coming danger. It was also added that the dam might burst in a month or in a year or it might not burst at all, in which case it was remarked that the authorities who had hit upon the telegraph as a method of dealing with an engineering difficulty would look rather foolish.

But the engineer who was responsible for these proposals, after carefully examining and studying the nature of the dam, held that the mass of water which would in any case be headed up, and which would eventually cut through the upper soft layers of the dam would cause a serious flood of practically the same intensity as would occur if the dam were left untouched. In that case also it would require exactly the same precautions to be taken as had been adopted to save life and property of the people concerned along the valley. He had roughly fixed the depth at 250 feet upto which the dam would be cut by the eroding action of the rushing water. As a matter of fact the flood torrent when it

occurred cut away some 380 feet before the body of the dam was able to resist the action. Under such conditions it seemed useless to spend large sums of money on such useless operations as cutting a channel, etc. The difficulties of making a cut of even 20 feet deep would, on account of large detached masses of rock, have been enormous and for a cut of 50 feet or 100 feet deep almost unsurmountable. The estimated cost of cutting a 50 feet channel was Rs. 150,000 or even more and, for a 100 feet cut about 5 lakhs, considering the scarcity of provision which exist in Garhwal. The time required for this work was very long, say about 3 years for 1,000 men working daily, on account of the large boulders and masses of rock of which the upper part of the dam was largely composed and also the labour for this work would have to be imported as sufficient labour was not available locally. In any case so large an expenditure was not recommended in view of the very doubtful advantages that would result from it. As for any other form of engineering treatment such as masonry weirs, outfalls, shoots, etc. their construction was considered impossible in the time available and their cost in any case was utterly prohibitive.

The other criticisms made were that the heights of the safety pillars along the valley fixed by the engineer responsible for these arrangements, were arbitrary and absurd, and that the rate of 20 miles an hour given by him as the velocity at which rate the flood, which was doubted, would pass down the valley, was much exaggerated and improbable: and that dismantling the bridges and opening a telegraph line were not required. Even in well-informed circles, it was maintained that there would be no cutting of the dam and hence the lake water rising to the top of the dam would pass quietly over the crest and down the face of the valley into the regular river channel without causing more erosion.

These views were not only whispered, but they were embodied in letters and went far to imperil the success of the carefully planned scheme of operations which had been approved by the Chief Engineer and sanctioned by the Government. It is not uncommon that the deeds of prominent persons are subjected to criticism and hinderance, sometimes with bad motives. Thanks to the perseverance and endurance of Lt.-Colonel Pulford, R.E., who not caring a fig for such sarcastic comments went on with his scheme, the lives and property of the people concerned were saved.

Progress of the work.— It was found by Lt.-Colonel Pulford on July 6, 1894 that a great change in the condition of affairs in Gohna Lake had taken place since 14th December, 1893, when he first visited the place. Since then the lake level had risen about 160 feet, and most of the former land marks, villages, trees, etc. had been blotted out by the rising water. The Lake on that date had become a vast sheet of water nearly 4 miles long and half a mile broad and had stretched far away into the mountains. He found some changes in the dam as well, *viz.* a perceptible increase in the depth of the gullies cut by the rain in the down stream face, and the presence of numerous small streams of percolation which, issuing from points in the lower part of the talus, united at the foot to form a well-marked stream of about 30 cubic feet per second. The first appearance of slight percolation was noticed before 2nd June, 1894, at the toe of the dam.

Sections and stations and their charges.— On 30th July, 1894, the Deputy Commissioner, Garhwal, was appointed as civil officer in charge of the operation along the entire line which was divided into three sections under the charge of the Deputy Collectors of the respective sub-divisions, and civil functionaries were posted to each station of importance along the line for administrative work and necessary help. P.W.D. officers were also detailed to each of the stations for technical work and observations. All Public Works officers were at their posts along the line by the 1st August, 1894.

Message to Government of India.—The following telegraphic message was submitted by the North-West Province and Oudh (now United Provinces) Government to the Gov-

ernment of India, Public Works Department, Simla, on August 7, 1894:

"Daily rise of lake averages four feet; level of lake water on 4th August, 5,768 ft. leaving 82 feet between it and lowest point of top of dam. Percolation heavy, but water clear. All officers are now at their posts along the valley line and telegraph open at all stations. Dismantling of Rudraprayag and Chatuwapipal bridges nearly completed; Jakhni and Chamoli bridges nearly down. None others will be removed. Recent heavy rainfall has not apparently extended to Gohna, where rainfall for week ending 4th August, was 3.9 inches only."

First symptom of the catastrophe.—On 10th of August, 1894, the first symptom of approaching collapse was wired by the P.W.D. Officer in charge Gohna lake, after the heavy rain of 9th August, 1894. A serious slip occurred then in the downstream face of the dam, leaving an almost perpendicular section, 400 feet high. The percolation was heavy and running over the boulders of the river bed.

Wire to Government of India. This event was immediately wired at Simla with further information that the slip had been responsible for the death of a man known as Gohna *faqir*, his wife and three children. They were removed twice before from the dangerous place but they persisted and went there again where they perished by the slip.

First Warning issued from Gohna.—The first warning was telegraphed from Gohna on 11th August, 1894 to all concerned that the lake would escape within 15 days' time subsequently saying that the lake was only 50 feet from the top of the dam. The position was getting critical day by day as the percolation was steadily increasing so much so that it was 350 cubic feet per second on 12th August, 1894.

Another Wire to Government of India.—Another wire was sent to Simla on 18th August, 1894 saying, "Lake level is now 25 feet from lowest point of dam and must reach top within the week. Percolation is decreasing, which looks as though the big slip in the tail had consolidated the body of the dam. Further cutting has occurred in tail, face of which is not now so precipitous as immediately after the slip in it. . . ."

24 Hours Warning.—Lieutenant Crookshank, R.E., the P.W.D. officer in charge at Gohna flashed the warning message on the 22nd August, 1894 that the lake was expected to escape within 24 hours. In order to bring on the flood early in the morning of the 24th August, 1894, he cut 2 ft. 6 in. deep channel in the crest of the dam; but on account of increased percolation and less rainfall on the previous day, the lake rose so slowly that it did not reach the bottom of the cut until the afternoon.

It was attempted that the flood should occur during the daylight, so the cut was filled up so that the overtopping might take place on the morning of 25th August, 1894. Accordingly the water began to trickle over the dam through the cutting at 6-35 a.m. on 25th August, 1894. The destructive action was very slow till about 3-30 p.m.; but at 2 p.m. the alarming extent of percolation caused sudden cutting back of the dam on the downstream side within 1,000 feet of the overflow point.

Last Warning.—On 25th August, 1894, at 3-30 p.m. a last warning message was sent out saying that the dam was cutting back and the catastrophe was expected during the night. Further observations could not be made by the engineer in charge Gohna lake as the slip was obscured by heavy rain and mist, but at 11-30 p.m. he heard a loud crash and dust was observed to rise from the dam. He, with the *patwari* civil functionary) went down to the dam to make final inspection of the condition of the dam at 12 midnight and found that the dam had been completely broken and the lake water was rushing down furiously. While the engineer and the *patwari* were standing there, the ground beneath at once sank 4 feet deep as the effect on the dam had been very marked. After this inspection the engineer at once sent out a wire at 20 minutes

Fig. I

Partial view of Gohna Lake showing the entrance. The Nandakna or Nandaghungti Peak is seen on the background.

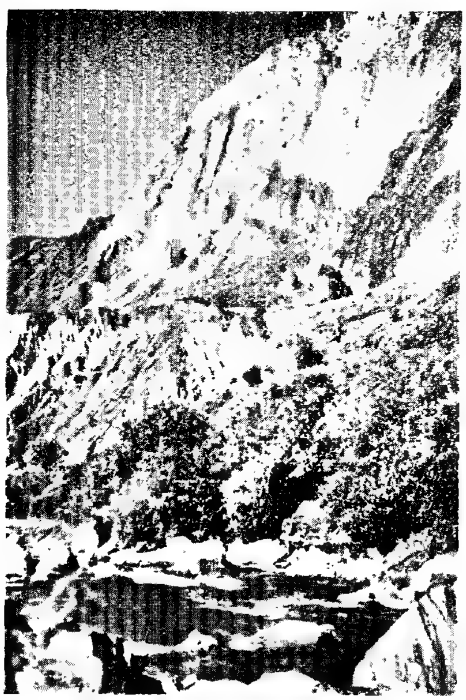
Photo: D. Stewart. I.F.S.

Fig. II

Full view of Gohna Lake showing the exit and the Birahiganga passing out of it.

Photo: D. Stewart. I.F.S.

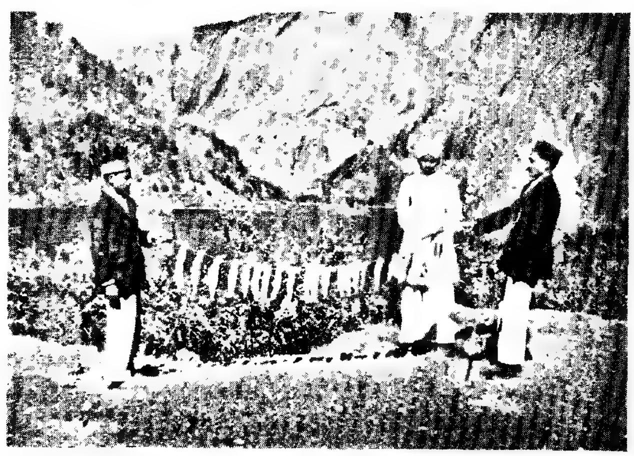
Fig. III



Gohna slip which dammed the Birahiganga and formed Gohna Lake showing the height of the dam up to which water was impounded.

Photo: D. Stewart. I.F.S.

Fig. IV



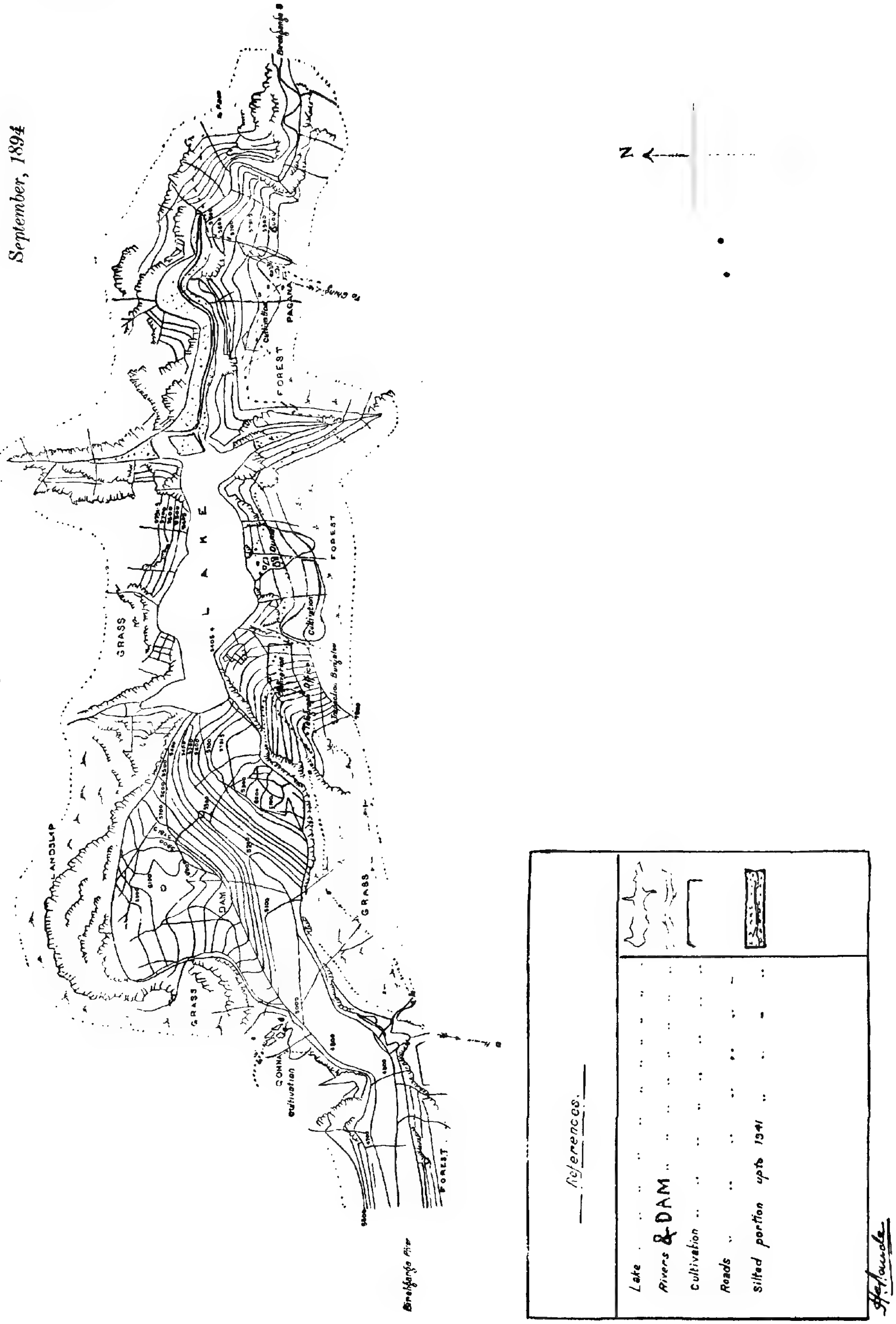
25 trout caught by Mr. T. J. C. Acton, I.C.S., on 14-4-1943, in the river above the lake, weight 14½ lbs. The three largest are 1¼ lb. each.

Photo: T. J. C. Acton, I.C.S., Commissioner, Kumaun, U.P.

PLAN

MAP SHOWING GOHNA LAKE

September, 1894



after midnight, i.e., 0.20 hours on the 26th August, 1894, reading "A very heavy rush of water is passing over the dam" and Hardwar was warned at 5 a.m. on 26th August, 1894, to expect a heavy flood. With the advent of daylight it was seen that the lake had become stationary and a permanent outlet had been formed for the water. The total fall of the lake during the night was observed to be 390 feet. About 10,000,000,000 cubic feet of impounded water was released within $4\frac{1}{2}$ hours.

August 26th, 1894, marks a great day and will ever remain memorable in the annals of Garhwal when the thrilling noise and awful sight of the Gohna flood, which passed through the very heart of the district, caused very anxious juncture for the people concerned. It was no wonder that the people thought for the moment that the end of the world had come!

What to-day is subject matter of interest was once a horrible calamity for the people inhabiting the Alaknanda valley where the dam burst and flood was caused from Gohna right down to Hardwar and onwards.

Permanent Lake.—The lake now left permanently measured 3,900 yards long, 400 yards wide (average) and 300 feet deep near the dam (*vide*, map in *Plate* 4). It was also observed that the bed of the lake had silted up about 85 feet. The table on page 59 shows the velocity, time and height of the flood water reaching different stations.

Damage done by the Flood.—Besides the damage noted in brief in the last column of the table on page 59 much damage was done to the road in bits measuring about 56 miles. 13 *dharamshalas* built from the *Sadabart* Charity Fund at the disposal of Government were destroyed. In addition to the above there was enormous destruction of private property in all the villages and towns along the valley. The floods swept away all vestige of habitation at Nandprayag, Karnaprayag, Srinagar and smaller villages near the river bank.

The total damage caused by the flood to public property was estimated as follows:

	Rs.
Damage to roads and bridges ...	49,850
Damage to government buildings	8,000
Damage to dispensaries and *dharamshalas*, constructed from the *Sadabart* Fund ...	37,500
Total ...	95,350

As soon as the flood was over and there was no more danger, arrangements were made by the P.W.D. to repair the damage at each station. Fresh *jhulas* (rope bridges) were at once put up and roads were repaired to allow of public traffic.

The arrangements made by civil officers for the protection of the persons concerned and patrolling the roads along the valley were commended to be admirable. The P.W.D. officers who were responsible for the technical part of the operation did markedly well, and were the recipients of congratulations from H.H. the Lieutenant-Governor.

H. H. the Lieutenant-Governor sent the following telegram after the conclusion of the Gohna flood:

"The Lieutenant-Governor has great pleasure in conveying to all the officers employed in connection with the Gohna landslip, by permission of the Viceroy, the expression of His Excellency's very sincere congratulations on the success which has attended the precautions taken to prevent loss of life. His Excellency considers great credit is due to those who were responsible for the arrangements."

Garhwal and specially the people of the Alaknanda valley will ever remain grateful to the (now obscure) engineer (Lt.-Colonel Pulford, R.E.) whose talented and thoughtful scheme of the flood, inspite of undue criticisms, saved the lives of the thousands of people along the valley and their movable property.

Ever since the formation of the permanent lake the upper portion of the lake and the northern loop have much been silted up. The

southern loop is silted slightly at the top as the stream coming to it is not large. Silting is still going on and it is presumed that the whole lake might be silted up after a few hundred years.

The occurrence of the Gohna flood was so important and widely known that a new era started after it in Garhwal district specially in and near the Alaknanda valley. Particular events are reckoned from Gohna flood (*birahi ka sal*). People often say that such or such an event was of *birahi ka sal* or so many years after or before *birahi* (Gohna flood). A local man prepared a poem in local language describing Gohna flood and the damage caused by it. It is out of print now but those who read it have still a memory of the events of the flood.

Trout Fishery of the Gohna Lake

Anglers' thanks are due to Mr. Wyndham, the then Commissioner of Kumaun and Mr. A. E. Osmaston, the Divisional Forest Officer, Garhwal, whose initiative and efforts respectively in introducing trout fish in the Gohna lake in 1917-18, now afford the finest trout fishing in British India in the lake. It is about seven days' march from Ranikhet. It is an out-of-the way place but visitors are also rewarded with some of the finest scenery in the world.

It was decided in 1917-18 to attempt to stock the lake with trout and 24,000 ova were brought from Bhowali in Naini Tal division, of which 13,000 were reported to have hatched out. Again 30,000 ova were brought in 1918-19, of which 19,000 were reported to have hatched out.

Trout in Bhowali were said to have been imported from Kashmir some years before. Subsequently in 1930 one more artificial hatchery was started at Talwari near Gwaldam in Garhwal district. Since a natural trout hatchery had been established in Gohna lake and in comparison with cost of maintenance there was less success in obtaining trout from Bhowali or Talwari hatcheries for stocking rivers, the Bhowali one was closed down sometime in 1932 and subsequently the Talwari hatchery in 1937. The Gohna lake is full of trout now and as many fry as are required are annually available for stocking the rivers.

Records of stocking the rivers.—The work of stocking the rivers from Gohna lake was started from 1935 as follows:

1935—Nandagini river—605 fry of 2-in. to 6-in size.

1936—Nandagini river—995 fry of 2--in. to 3-in size.

1937—Nandagini river 974 fry of 2-in. to 3-in. size.

1938—Nandagini river—600 fry of 1-in to 2-in. size; and 50 fry of 5-in. to 6-in. size.

Knilganga river—300 fry of 1-in. to 2-in. size.

1938—Nandagini river—40 fry of 6-in. size; and 15 fry of 12-in. size.

Knilganga river—400 fry of 1-in. size; and 15 fry of 3-in. to 4-in. size.

Ranikhet Cantt.—300 fry of 1-in. size.
Naini Tal—500 fry of 1-in. size.

1940—Nandagini river—600 fry of 1-in. to 2-in. size.

Knilganga river—600 fry of 1-in. to 2-in. size.

1941—Nandagini river—700 fry of 1-in. to 2-in. size.
(Figures for Knilganga are not available.)

1942—Nandagini river—1,000 fry of 1-in. to 2-in. size.
(Figures for Knilganga are not available.)

Trout has successfully been introduced in the Nandagini river and the fact is authenticated by the following records:

(1) Major Aird Smith caught two trout in the Nandagini river near Ramni-Kanol road crossing in 1937, but he found none in the Knilganga.

(2) Mr. R. V. Vernede, Deputy Commissioner, Garhwal, caught one trout 1 lb. in weight at the same place in the Nandagini on October 17, 1941.

(3) Mr. T. J. C. Acton, Commissioner, Kumaun division, fished at the same place very recently. His letter is reproduced below as it is the latest and proves still better results of stocking the river with trout:

"I fished at Chura Baggar on the Nandagini on April 19th and 20th (1943) and caught 3 trout (1 half pound and 2 ¼ lb.) below the bridge and 7 (1 of 1 lb., 1 of 12 oz. and the rest about 10 oz.) in the first half mile of the river above the bridge. All on fly. I went

up about 1 mile, but the river above the first half mile is too rapid. The best time was after 6-30 p.m. (*vide Fig. IV, Plate 3*).

I also fished the Kailganga about two miles above the camping place 1 mile above the Pindar Junction but did not catch or see any trout."

Local enquiries by the writer also show that occasional trout were found by local fishermen in the unprohibited area of the Nandagini river as far as Thirpag which is only about 4 miles from its junction with the Alaknanda at Nandprayag. This shows that trout has been propagated in the Nandagini river satisfactorily. Stocking the above rivers is still going on and in the long run, it is presumed that all the suitable rivers of the district will be stocked with trout, when Garhwal district should become a fisherman's paradise in competition with Kashmir and Kulu, to the great benefit of the local inhabitants, not only financially but since their food supply will also be considerably increased by the trout which overflow from waters where netting is prohibited.

There is a boat maintained by the forest department for fishing purposes at Gohna and the following fees are charged for fishing in the lake:

	With government boat			*Without boat*		
	Rs.	a.	p.	Rs.	a.	p.
Per day ...	1	0	0	0	8	0
Per week ...	5	0	0	2	8	0
Per month ...	15	0	0	10	0	0

The permit for fishing in the lake is issued by the Divisional Forest Officer, Garhwal division, Pauri, Garhwal (U.P.). The fishing rules for the guidance of the fishermen are printed on the back of the permit which should be gone over before starting fishing in the lake.

There are two log books kept with the *chaukidar* of the boat and boat house at the lake. The present man is only a *chaukidar* and not a boatman. Though he is not trained, he knows rowing well. He gets only a retaining fee of Rs. 4 per month. His extra services are made good by giving him a reward. He is ordered to produce the log book to the visitors. In one book visitors are requested to make direct notes regarding days of stay there, number and size of trout caught, flies, rods, etc., used and any suitable remarks for its improvement; the other book is a typed copy of the remarks by previous visitors.

The following is an interesting note written by Mr. D. Stewart, I.F.S., Conservator of Forests, Kumaun Circle, dated 25-10-1938:

"The lake is undoubtedly teeming with trout which are in excellent condition. It also forms a large natural hatchery from which suitable rivers in Garhwal and Almora districts can be stocked, and we are now taking measures to expedite the stocking of rivers. There seems no reason why Garhwal should not ultimately become a trout fisherman's paradise, to the great benefit of the local people."

The most convenient path to the lake from the Kathgodam railhead of the Oudh and Tirhut (R. K.) Railway is as under:

Kathgodam to Ranikhet (altitude about 6,000 ft.) by motor—50 miles.

Ranikhet to Garur (altitude about 3,500 ft.) by motor—42 miles and on to Dangoli rest house—2 miles by road.

Garur to Gwaldam (altitude about 6,944 ft.) by road—8 miles—forest rest house.

From Gwaldam there are two paths leading to Gohna as follows:

(*i*) Gwaldam to Tharali (altitude about 4,000 ft.) by road—8 miles—forest rest house.

Tharali to Dungri (altitude about 6,000 ft.)—6 miles—camping ground.

Dungri crossing a ridge about 8,000 ft. to Ghat (altitude about 4,500 ft.)—12 miles—dak bungalow.

Ghat to Ramni (altitude about 8,000 ft.)—*steep ascents in the beginning 9 miles*—camping ground.

Ramni to Gohna Lake, crossing a ridge 9,000 feet altitude to Gohna lake 5,000 ft. altitude—9 miles (forest rest house expected during 1943-44).

Total length of the route - 41 miles.

Or

(*ii*) Gwaldam to Debal (about 4,500 ft. altitude) - 6 miles—camping ground.

Debal to Lohajang (about 8,000 ft. altitude)—9 miles—camping ground.

Lohajang to Wan (about 9,500 ft. altitude)—9 miles—camping ground.

Wan, crossing about 10,000 ft. altitude ridge to Kanol 5 miles—camping ground.

Kanol right down to the Nandagini river and then gradually up to Ramni about 8,000 ft. altitude—14 miles—camping ground.

Ramni to Gohna lake meeting path No. *i*) already mentioned above 9 miles.

Total length of the route—52 miles.

It will appear that No. (*i*) is shorter than No. (*ii*) and also is better than the latter. In the former two rest houses can be had whereas there are none in the latter. These routes are shown in the map in Plate 2.

Coolies have to be arranged at Garur, the motor terminus, for the journey to and back from Gohna lake as that is the cheapest arrangement. Local coolies are difficult to procure and are also twice as costly.

A third route, still better, shorter and convenient, is expected shortly by motor from Kotdwara or Rishikesh railheads of E.I.R. to Karanprayag motor terminus and therefrom to Gohna about 35 miles in four easy marches by road along the Alaknanda and Birahi valleys. This motor-road is under construction and only the last portion of about 25 miles or so remains to be constructed in 1943-44.

The following information, taken from the log book at Gohna, is given for the guidance of the intending visitors:

Flies used.—Any large salmon fly, Greenwell's Glory, Wickham's Red Tag, Woodcock, Mole, Coachman's Zulu, Red Palmir, Red Ant, Jock Scot lure, Butcher, Wet Fly, Teal and Green, large double hooked peacock lure, any large lake variety: the larger and more highly coloured specially those with silver or gold border, etc., etc., flies are recommended by the previous visitors.

Spoons.—1 2-in. to 1 4 in. brass or silver spoon. Generally spoons were not found very successful with the exception of one remark which says that 1 2-in. silver spoon or pear spoon was found successful.

Largest trout caught.—Lt.-Col. C. A. Raynor, 1st Royal Battalion, the Jat Regiment, remarks that he hooked and played a fish for not less than 20 minutes, which in his opinion was not less than 6 lbs. Mr. W. F. Champion, I.F.S. now Conservator), noticed a number of very large fish up to 10 lbs. weight in the lake near the exit. A $2\frac{1}{2}$-lb. fish was caught by Major Aird Smith 4 10 Rajputana Rifles, on 18-10-37. The average trout are $1\frac{1}{2}$ to 2 lbs. though a number are caught under this weight also.

The charming and graceful lake is enjoyed by all visitors, who thank the forest department for introducing trout in the lake and affording fishing facilities with a boat. Intending visitors to Garhwal, therefore, should not miss Gohna trout fishing.

The forest department proposes to construct a forest rest house with 2 sets of rooms during 1943-44 in a commanding place by the side of the lake and also construction and improvement of existing paths from Ramni and Chamoli to Gohna fit for pack mules.

Any further information required by intending visitors to the Gohna fishery can be had from the Divisional Forest Officer, Garhwal forest division, P.O. Pauri, Garhwal (U.P.)

The writer's thanks are due to Mr. D. Stewart, I.F.S., director of timber supplies, New Delhi, for very kindly supplying him with various photographs of Gohna lake and the main slip which dammed the Birahi Ganga and formed the Gohna lake.

(Concluded.)

REFERENCES

(1) Narrative report of the Gohna lake and flood—by superintending engineer, II Circle (Nov. 1894).

(2) Damage caused by a land slip at Gohna on the Birahi Ganga in Garhwal District—N.W.F. & Oudh P.W.D. Proceedings (August, 1895)

Table referred to in para 4, col. 1 of page 55.

Station.	Distance (in miles). Between stations.	Distance (in miles). From Gohna.	Maximum height in feet of Gohna Flood above ordinary flood level in feet.	Times. 1st arrival of flood at.	Times. Highest level reached at.	Times. Finally subsided at.	Velocities in miles per hour. Between stations.	Velocities in miles per hour. Average from Gohna.	Velocities in miles per hour. As observed at each station.	Damage.
Gohna ..	..	..	280	25-8-94 23-18	Hours 23-30	Hours 4.0		..	..	Two houses in Gohna village destroyed by a slip caused by the Flood.
Chamoli ..	13	13	160	25-8-94 23-55	1-17	4-30	20	20	19	River bed raised 50 feet, Bridge abutment, temple, Dharamshala, Bazar, dispensary washed away.
Nandprayag ..	7	20	113	26-8-94 0-17	1-30	5-0	19	20	20	Suspension bridge over Nandagini river destroyed, also Bazar, Dharamshala and P. W. D. Godown.
Karnaprayag ..	10	30	130	0-50	1-45	5-0	18	20	19	Suspension bridge, Dharamshala, Temple, Police Lines and Bazar, destroyed.
Rudraprayag ..	21	51	140	2-00	3.45	7-30	18	18½	19	Suspension bridge, temple, Dharamshala and Bazar washed away.
Srinagar ..	21	72	42	3-25	4-40	11-0	15	18	15	Entire city including Raja's palace, dispensary, police, station and dak bungalow destroyed.
Deoprayag ..	16	88	70	4-53	7-00	14-34	11	16	16	Suspension bridge swept away and bazar much damaged.
Biasghat ..	11	99	88	5-50	8-50	15-55	11	15	20	Bazar destroyed.
Lachmanjhula ..	32	131	35	7-50	10-27	19-45	16	15	20	Bridge washed away, abetments however remained standing.
Rishikesh ..	2	133	18	8-00	10-35	20-0	12	15	..	No great damage done.
Hardwar ..	16	149	11	9-00	11-35	22-0	10	15	19	Ganges canal regulator damaged.

MANURES AND MANURING

By Sudhir Chowdhury

CHAPTER II*

Introduction.—The term "manure" originally had a much wider significance than it has to-day. Originally manures were supposed to pulverize the soil, and the French word *manaeuvrer,* from which the word manure comes, implies to work with the hand. On this account in bygone days, tillage and manure were synonymous terms, as exemplified by the statement of the historic English farmer Jethro Tull, who, about the year 1700 made the statement 'tillage is manure.' This idea probably originated through the observation that farm manures, which were the only manures in use at that time made the soil less cloddy. However, the term manure gradually came to be applied to any material, with the exception of water, which when it is added to the soil, makes the soil more productive and promotes the growth of plants. There are several ways in which manure applied to soils may increase plant growth:

1. By addition of the nutrient materials utilized by plants, which is the chief function of most of the special manures:

2. By improvement of the physical condition of a soil, which usually results from the application of lime and the incorporation of organic matter:

3. By favouring the action of useful bacteria, which is one of the beneficial results of farm manures and also of lime:

4. By counteracting the effects of toxic substances as for instance, the conversion of sodium carbonate into sulphate by gypsum, or the neutralization of acidity, or possibly the destruction of toxic organic substances by certain salts:

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*Chapter I was extracted and published in the *Indian Forester* in October, 1943.—*Ed.*

5. By catalytic action, either on chemical processes in the soil or by its influence on those bacteria that exert a favourable influence on soil fertility or by direct stimulation of the plant.

Plant-food Elements.—In describing the relation of manures to crop production, the fundamental considerations are, what are the plant-food elements and what are the sources and supply of these elements. Ten elements are usually considered as absolutely necessary for plant growth. They are carbon, oxygen, hydrogen, nitrogen, phosphorus, potassium, calcium, magnesium, iron and sulphur. Other elements, *e.g.* boron, chlorine, copper, iodine, manganese, silicon, sodium and zinc are sometimes found, their presence in the plant being due to special conditions under which it is grown.

The immediate sources from which the plant draws its food elements are the soil and air. Carbon is supplied wholly from the carbon dioxide of the air; while oxygen comes directly from the atmosphere or from water, which is also the source of at least a part of the hydrogen utilized in vegetative growth. The other elements except nitrogen in the case of legumes, which plants, under certain conditions are able to appropriate their nitrogen from the atmosphere, wholly or in part, are derived entirely from the compounds of the soil.

When we come to consider the soil we find that there are several sources of loss and gain of plant-food.

Sources of Loss.—1. *The Production of Crops.*—As already stated, the constituents of plants, with the exception of carbon and more or less nitrogen in the case of the legumes, are drawn entirely from the soil. The available soil supply, therefore, is depleted by the amount of such constituents which are removed in the crop. In a system of farming that involves the sale of the crops as such, the amount and composition of the crops measure the loss of the plant food to the farmer. When, however, crops are fed to animals and the resulting manures are applied to the soil, only a minor part of the commercially valuable materials used for plant growth are actually lost from the farm. The following table gives the quantities of the primary elements for plant growth that are removed from the soil by some of the more prominent farm crops.

Pounds of Nitrogen, phosphoric Acid and in 100 lbs. of various crops.

	Nitrogen	Phosphoric Acid	Potash
Corn fodder (green) ..	0.41	0.15	0.33
Corn fodder (dry) ..	1.76	0.54	0.89
Corn stover ..	1.04	0.29	1.40
Red top (dry) ..	1.15	0.36	1.02
Timothy (dry) ..	1,26	0.53	0.90
Red clover (dry) ..	2.07	0.38	2.20
Alfalfa (dry) ..	2.19	0.51	1.68
Barley straw ..	1.31	0.30	2.09
Wheat straw ..	0.59	0.12	0.51
Oat straw ..	0.62	0.20	1.24
Potato tubers ..	0.21	0.07	0.29
Sugar Beets ..	0.22	0.10	0.48
Mangel-wurzels ..	0.19	0.09	0.38
Corn Kernels ..	1.82	0.70	0.40
Barley (grain) ..	1.51	0.79	0.48
Oats (grain) ..	2.06	0.82	0.62
Winter wheat (grain)	2.36	0.39	0.61
Rye (grain ..	1.78	0.82	0.54
Buck wheat (grain) ..	1.44	0.44	0.21

2. *Loss by Drainage.*—When the amount of rain water is in excess of the amount which the soil will hold plus that which is given back to the air through evaporation and transpiration by plants, drainage occurs. Drainage water always contains more or less of the compounds that serve as plant food. The most important of these is nitrogen in the form of nitrates. In determinations made by Lawes and Gilbert, the quantity of nitrogen as nitrates annually removed in drainage waters varied from 318 to 579 pounds per acre. This loss is greatest in years of exessive rainfall and is larger from uncropped than from cropped land. The loss is increased by heavy applications of nitrogenous manures, especially of nitrates and ammonia salts. The proportions of phosphoric acid and potash in drainage water are very small indeed, the loss in this way being unimportant.

3. *Loss from Fermentations.*—It has been clearly shown that under certain conditions, especially when the soil contains large amounts of organic matter, without proper aeration, fermentations may occur which cause the loss of nitrogen from the soil in the free form.

The extent to which such loss occurs under ordinary conditions has never been quantitatively estimated.

Sources of Gain.—1. Manures.—The application of all farm manures and of all substances usually classed as manures, adds to the supply of the soil compounds which serve as plant food, the quantity of such additions depending on the composition and amounts of manures used.

2. *Rainfall.*—The precipitation of water, whether as rain or dew, brings to the soil certain compounds which are washed out of the atmosphere, the most important of these from the standpoint of plant growth being nitric acid and ammonia. Observations made at Rothamsted in the years 1853 to 1856 show that the amount of nitrogen thus conveyed to the soil varied from 5.9 to 8 pounds per acre. Other observers have found the quantity to be as high as 11 pounds per acre.

3. *Fixation of Atmospheric Nitrogen through the action of minute forms of vegetable life.*—It has been shown beyond question that certain forms of bacteria whose life is associated with leguminous plants, have the power of enabling the host plant to acquire atmospheric nitrogen. To the extent that the substance of these plants remains in the soil and decays this action increases the supply of soil nitrogen. Other observations indicate that certain species of bacteria cause the fixation of the atmospheric nitrogen directly in the soil, and evidence exists which appears to indicate that some of the lower fungi are similarly endowed.

4. *Supply of Plant-food from the deep layers of the soil.*—The movements of soil water cause more or less transference of soil compounds from one layer of soil to another. This movement is sometimes upward and sometimes downward. During that part of the year when the rainfall is scanty and the movement of the soil water is almost entirely to the surface, there is unquestionably a transference of some soluble matters from the deeper to the upper layers of the soil. In view of the fact this occurs generally during the season when crops are making active growth, this is a matter of considerable importance. It is not possible to know, of course, the extent to which the upper layers of the soil, in which the roots of the plant are most active, have their plant food supply reinforced from the deeper layers.

The Balance of Plant-food supply and the availability of the food.—It is evident from the foregoing that there are constantly going on, through various causes, losses and gains of the supply of available compounds which serve as food for plants. To what extent the store of plant food is being diminished or increased in general or particular localities, it is not possible to estimate Nitrogen is constantly in circulation from the air to the soil from the soil to the plant, to drainage-waters and to the air, and from the plant and air back again to the soil. But just what proportion of loss or gain occurs of the forms of nitrogen that are available to the plant, it is impossible to state. Any definite figures on the point must be regarded as largely speculative.

When we consider the constituents of the soil we find that they exist in great store. Analyses at the New York Agricultural Experiment Station of samples of soils taken from nine localities in the State of New York, show that the soils which these samples represent contain on one acre to the depth of one foot, 1900 to 7260 pounds of nitrogen, 2400 to 4800 pounds of phosphoric acid and 5400 to 57500 pounds of potash; this calculation being made on the assumption that the air dry soil on one acre to the depth of one foot would weigh three million pounds. It is evident that these quantities represent, if entirely utilized, what would be sufficient for the production of crops during a long series of years. We are not in a position to know, however, the rate at which these quantities of compounds in the upper layers of soil are diminished, if at all, under the usual systems of farm management. It is certainly true that large areas of land when managed in accordance with what are regarded as correct practices have continued to grow undiminished and luxuriant crops during a long series of years.

Roughly speaking an average soil contains enough plant food for a hundred full crops, yet without fresh additions of plant food as manures the production will shrink in a very few years to one-third or one-fourth of the average full crop. Once, however, the yield has reached this lower level, it will remain for an indefinite comparatively stationary, affected only by the fluctuations due to season. At Rothamsted, for example, wheat has been grown year after year on the same land for sixty-five seasons, and one plot has received no manure throughout the whole period. In the first few years the crop declined steadily, but since then little or no further drop has been seen. The yield remains at about 750 pounds per acre for each successive ten years' average, and has considerably overtopped that amount during recent favourable seasons. This yield, however, of 750 pounds of corn per acre is only about a third of that obtained on the adjacent plots receiving manure every year during the same period.

These facts lead to a new point of view: it is not merely the amount of this or that plant food present in the soil which must be taken into account but also their mode of combination. The material may be present in the soil but yet may be beyond the reach of the plant in a locked-up or dormant condition. The plant can only obtain substances which have been previously dissolved in the water contained by soils in the field, hence plant food in the soil is only available for the plant in so far as it can pass into solution.

Accepting, then, the fact that the soil contains a vast store of all the elements necessary to its nutrition but in forms of low availability, it remains to ascertain which of the elements are normally likely to fall below the current requirements of the crop. This is a question that can only be solved by field experiments, and though the answer will vary with each crop and each soil, yet certain general principles at once become evident and upon them the whole idea of a manure is based. For example, field experiments at once show that certain elements indispensable to the plant as seen from water-culture experiments, need not be supplied to the crop in the field, since the soil is practically always able to provide a sufficiency. To judge by field experiments alone there are only three elements required for the nutrition of the crop—nitrogen, phosphorus, and potassium—and this means that soils can usually supply the elements necessary to the plant in sufficient quantities except in these three cases. Calcium, while necessary in large quantities in a soil, is largely an amendment, and very seldom may limit plant growth because of being in too minute quantity to supply the food needs of a crop. The lining of a soil is for other purposes than the supplying of calcium for plant nutrition. Manures, then, are usually designed to supply deficiencies in the soil, and for all practical purposes are to be regarded as consisting of compounds of nitrogen, phosphoric acid and potash either singly or together. They may also contain other plant food elements, *e.g.*, magnesium, calcium, sulphur, iron etc., but these though equally necessary to the plant are not counted, since the unaided soil may be crusted to furnish the crop with them.

To summarise the position we have reached: a manure must contain one or more of the three elements, nitrogen, phosphorus and potash, which alone among the various elements necessary to the nutrition of the plant cannot be supplied by cultivated soils in amounts sufficient for profitable crop production. The soils do contain these substances in comparatively enormous quantities but the distinguishing feature of a manure which makes it effective when supplied in quantities comparable with those removed by the crop, is its 'availability.'

Terminology.—In all text-books on the subject the term 'manure' and 'fertilizer' are very often used indiscriminately. It is not possible to make a very clear distinction between the two terms. Hall remarks "Farmyard manure is the typical manure; marl or chalk would no longer be regarded as manure because they do not feed the plant directly; while substances like basic slag or nitrate of soda which simply supply one or other element in the nutrition of a plant should be

termed 'fertilizers' rather than artificial manures. The distinction is not, however, clearly drawn, and manure and fertilizer are generally and unconsciously used as interchangeable terms." According to Parish and Ogilvie, "The word 'fertilizer' may be regarded as the modern word for manure. It is one which has been largely adopted in America."

Literally, however, the terms 'manure' and 'fertilizer' are synonymous and are generally applied to all substances, which are added to *the soil in order to increase its productiveness* or to restore the natural productive power lost by repeated cropping. But sometimes, however, a technical difference is made and the term 'manure' is applied to bulky materials, generally made from the farm refuses and by-products and 'fertilizer' to substances that have been chemically prepared, are much lighter in form, effective more quickly and usually commodities of extensive commerce. Besides, a functional difference is also often made and the term 'manure' is applied to materials which in addition to supplying nitrogen, phosphorus and potassium supplies organic matter and many other elements such as calcium, magnesium, iron, sulphur, etc., and 'fertilizer' to substances which supply any one are all the three essential elements—nitrogen, phosphorus, and potassium. In this treatise, however, the terms 'manure' and 'fertilizer' will be used as interchangeable terms.

Classes of Manures.—Manures are variously classified and in almost all cases in a somewhat loose manner. Sometimes manures are classified into natural manures, artificial manures and mineral manures. "By natural manures are usually meant those produced on the farm itself; they consist mainly of the remains of plants and animals. By artificial manures are indicated products as are the results of some manufacturing process *e.g.*, sulphate of ammonia, superphosphate, and basic slag. But practically speaking any concentrated fertilizer that is brought on to the farm in bags though its origin be as natural as the sea birds' experiment 'guano' or the ground seeds known as 'rape dust' gets called an artificial manure in contradiction to the farmyard manure which is the normal product of the farm." By mineral manures are distinguished such substances as are found in the ash of a plant—the phosphates, the sulphates, and chlorides of the alkalies or alkaline earths; "the compounds containing nitrogen are regarded distinct, since they are ultimately of organic origin, even when they consist of such obviously mineral substances as nitrate of soda or chloride of ammonia. The term 'cinreals' has also been proposed *in place of mineral manures or* ash constituents."

A second classification is into—single and compound manures. By single manures are meant fertilizers which contain only one ingredient of value to the plant; the compound manures are those which contain two or more fertilizing ingredients. The compound manures are further divided, according to this classification, into nitrogenous, phosphatic and potassic manures according to the elements which predominate.

A third method divides manures into two classes—complete and *incomplete manures.* A complete manure is one which contains every ingredient in which a soil is likely to be deficient. An incomplete manure contains one or more, but not all of the necessary manurial ingredients.

A fourth method treats manures under three heads—organic or natural manures, inorganic manures or fertilizers, and indirect fertilizers. By organic or natural manures are meant substances composed of the remains of vegetable and animal substances. Inorganic manures or fertilizers are those which are of mineral or chemical origin. Indirect fertilizers are those which help plant growth indirectly by accelerating physical, chemical or biological changes in the soil.

A fifth classification is into natural and artificial manures. "By natural manures are usually meant those produced on the farm itself; they consist mainly of the remains of plants and animals. By artificial manures are indicated products either derived from mineral deposits or manufactured in the arts,

though the term is often extended to substances of animal or vegetable origin which are not produced on the farm."

A sixth classification is into general manures and special manures. "A general manure is one which contains all the necessary constituents of plant food and thus imparts to the soil to which it is applied a complete store of the nutriment required for fertility." "A special manure contains only one or two constituents of plant food, and cannot therefore supply all the requirements of the plants."

From a critical consideration of all these classifications it will be evident that none of these classifications is satisfactory. Manures are very numerous as to kind and a certain manure may have a number of distinct functions.... this makes any scientific and strict classification of manures extremely difficult, nay, almost impossible. In this treatise however, manures will be treated under the following heads:

I. General Manures.—A general manure is one which contains all the necessary constituents of plant food and thus imparts to the soil to which it is applied a complete store of the nutriment required for fertility *e.g.*, farm manures, green manures, night soil, sea-weed and water hyacinth, guano, fish, crab, lobster and similar wastes.

II. Special Manures.—A special manure contains only one or two constituents of plant food and cannot, therefore, supply all the requirements of the plants. They are further divided into nitrogenous, phosphatic and potassic manures according to the single fertilizing material which they contain or which predominate in their constitution. Nitrogenous manures are further dealt under two heads *inorganic* and *organic* according to the form of combination in which the nitrogen is held in the manure.

III. Catalytic Manures.—A catalytic manure is one which when added to a soil increases plant growth by apparently accelerating the processes that normally take place in soils.

IV. Indirect Manures.—An indirect manure is one which when added to the soil helps plant growth indirectly by accelerating physical, chemical or biological changes in the soil.

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—*The Allahabad Farmer, July*, 1943.

PYRETHRIN CONTENT OF INDIAN *PYRETHRUM*

During the past few years much interest has been taken in the cultivation of pyrethrum (*Chrysanthemum cinerariaefolium* Boic.) in India and with the help of the Imperial Council of Agricultural Research experimental cultivations have been started at a number of stations. As reported by Burns,[1] pyrethrum has failed to establish itself at Dharwar, Poona, Saharanpur, Dehra Dun, Chaubattia (Ranikhet, U.P.), Sakrand (Sind), and Ranchi, but the attempts have succeeded at Murree, Kulu, Palampur, Kashmir and since the time of the above report, also at Shillong, Mayurbhanj, Kodaikanal, Coonoor and Mysore.

It is well-known that success in the cultivation of pyrethrum depends upon the type of soil, altitude of the locality, climate, distribution of rainfall, cultural and manurial treatment, conditions of flowers at harvesting, etc. Full data are not yet available for all the

stations where pyrethrum has been a success and in their absence it is not possible to discuss the reasons why the pyrethrum grown at Kodaikanal is superior to that grown in Murree but it may be stated that the Indian experiments appear to prove what has been established elsewhere, namely, that pyrethrum grows best in localities with 40—80 inches of rainfall, well distributed throughout the year. Pyrethrum failed to flourish at Dehra Dun because of nearly 60 inches of rainfall during the three rainy months, which damped off the plants.

In the following table the pyrethrin content of pyrethrum flowers (open), obtained from different localities, is recorded and for comparison the figures for Kenya, Japanese and Dalmatian flowers are also given. All the figures given in the table are comparable, as they have been obtained by the same method of assay, namely, a combination of Seil[2] and Pantsios.[3]

Locality	Altitude	Annual Rainfall	Normal-rainfall in July, August and September	Pyrethrin I	Pyrethrin II	Total Pyrethrins
	ft.	in.	in.	%	%	%
Kashmir—						
Tangmarg ..	7,200	15+ winter snow	11	0·35	0·57	0·92
Baramulla ..	5,200	38	6	0·32	0·62	0·94
Punjab—						
Palampur ..	4,500	101	72	0·22	0·68	0·90
Murree ..	7,113	57	31	0·37	0·66	1·03
Kulu ..	4,500	39	15	0·35	0·40	0·75
N. W. F. Province—						
Tarnab ..	2,000	17	6	0·31	0·59	0·90
United Provinces—						
Dehra Dun ..	2,239	87	59	0·63	0·15	0·78
Garhwal—						
(Pandar Range) ..	4,000	70	44	0·29	0·28	0·57
Madras—						
Kodaikanal ..	7,688	62	19	0·76	0·62	1·38
Coonoor ..	5,730	64	10	0·44	0·45	0·89
Assam—						
Shillong [4] ..	4,921	84	40	..	..	1·41
Orissa—						
Mayurbhanj [6] ..	1,600	60	32	..	..	1·15
Mysore—						
Bangalore [5] ..	3,021	35	16	..	..	0·80
Kenya ..	79,500	40—65	..	0·77	0·56	1·33
Japan ..	..	40—80	..	0·38	0·63	1·01
Dalmatia ..	..	40	..	0·35	0·63	0·98

FOREST RESEARCH INSTITUTE, DEHRA DUN :
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S. V. PUNTAMBEKAR.

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A NOTE ON *PYRETHRUM* CULTIVATION

(Issued by the Forest Research Institute, Dehra Dun)

Five-and-a-half ounces of seed of *Chrysanthemum Cinerariaefolium* were obtained by the Forest Botanist from Suttons, Calcutta, and distributed in March, 1941, by the Silviculturist, Forest Research Institute, to the following officers for trial in suitable localities.

Silviculturists, Assam, Bengal, Bombay, Central Provinces and Berar, Madras and Punjab and the Conservators of Forests, N.W. F. P., and Baroda State.

The following is a summary of the results of these experimental plantings, compiled from reports received up to the end of August, 1943.

Assam.—Seeds were sown in the nursery at Shillong (5,000 ft.) and Umsaw (2,000 ft). Seedlings from the former were transplanted about the middle of September, 1941, a few of which survived to 1942, when they flowered also. The plants at Umsaw died.

Bengal.—The seed was tried at 4 places:

(1) Ramam nursery, Singalila range, Darjeeling division. Elevation 7,958 ft. Rainfall 121.9 inches. Sown on 29th April, 1941. Germination commenced on 16th May, 1941, and at completion amounted to about 10%. 110 seedlings, in poor condition and about $2\frac{1}{2}$ inches in height, were alive in November, 1941. In April, 1942, these 110 plants were reported as healthy and spreading, with shoots 6 inches high and clumps 10 inches in diameter. Flower-buds were also appearing at that time. About 3 ounces of seeds were collected from these plants in July, 1942, and tried in other localities. See (4), (5) and (6) below.

(2) Risheehat tea estate. Germination was nil, possibly due to overwatering.

(3) Pashok tea estate. Germination was about 15% but only 11 plants were reported as existing in April, 1942, though healthy and expected to flower shortly, then.

(4) Kalimpong division. The seed was sown late and failed to germinate. Of the one ounce of seed received from Ramam, half the quantity was sown on 9th September, 1942, in the development area, Kalimpong (elevation about 4,100 ft., rainfall about 80 inches), as follows:

(*a*) $\frac{1}{4}$ oz. direct in lines at site, which has been bare for years. Watering was done. Only about 10 to 12 seeds germinated but they died within a week.

(*b*) $\frac{1}{4}$ oz. was sown in a shaded nursery bed. The seed started to germinate within a month. About 250 seedlings were obtained. 130 seedlings were pricked out to 6 in. × 6 in. on 10th March, 1943, and others later. Plants were reported as looking quite healthy. The remaining half ounce of the seed was set apart for trial later. The remaining quantity of the seed collected at Ramam was tried in two other localities as follows:

(5) *Kurseong Division*—

Locality—Mahaldaram 3, reserve forest Kurseong range.

Aspect—Western.

Elevation—About 6,300 ft.

Soil preparation—Bed of 12 ft. × 6 ft. dug out to a depth of 1 ft. with spade and shaded with bamboo mats.

Time of sowing—25th September, 1942.

Quantity sown—1 ounce.

Germination commenced—6th October, 1942.

Germination completed—31st October, 1942.

Germination %————Almost cent per cent.

Height before pricking out—2 in. on 3rd March, 1943.

(6) *Takdah nursery*—

Elevation 5,300 ft.

Aspect—Eastern.

Half an ounce of seeds in shaded and another half ounce in unshaded beds was sown

broadcast on 17th September, 1942; germination commenced on 3rd October, 1942, but was poor in shaded beds. By the end of March, 1943, there were 55 seedlings in shaded beds and 350 seedlings in the open beds. The latter were bushy and healthy and about 1 inch in height.

Bombay.—The seeds were sown in the Poona and Haliyal experimental gardens on 19th May, 1941. They did not germinate.

The report of the Economist-Botanist to Government, Bombay, Poona, states that no part of Bombay appears to be suitable for *pyrethrum* cultivation. The plants were raised at Poona and transplanted at Bassein (sea level) and Mahabaleshwar. Two-month old seedlings did not establish themselves at Bassein and six-month old seedlings transplanted in December, although they grew well, succumbed soon after the rains set in during June. Similarly, at Mahabaleshwar, seedlings transplanted in January grew well, but perished after the commencement of heavy rains in June.

At Poona plants reach the flowering stage about one year after the date of sowing, July and August being favourable months for flowering. The vegetative parts of plants grow to a height of about 6 to 12 inches.

Central Provinces.—It is reported that Central Provinces is not a suitable place for the cultivation of *pyrethrum* on a large scale. The seed was tried at Betul, Hoshangabad, Chikada and Nagpur, but no germination was obtained at any place, excepting at Pachmarhi (Hoshangabad), where a few plants grown under garden conditions flowered.

Madras.—The seed supplied was sown at 4 places and resulted practically in failure. Germination obtained:

(1) Denkanikota: 2, of which 1 died in May, 1942.

(2) Palghat: 10, of which 5 died by 23rd June, 1941.

(3) Wynaad (Begur): No germination.

(4) Nilgiris: 2, of which however, both died.

Subsequently the Madras Silviculturist had been able to raise quite a large number of seedlings for large-scale planting in the Nilgiris division and about 20,000 plants raised mostly from Kenya seed are being planted out. He obtained no germination from American seed.

From other work also it is reported that *pyrethrum* can be grown successfully at high elevations, such as at Kodaikanal (Madras) and the Nilgiris. At Coonoor there are 30 acres and at Ootacamund 6 acres of successful plantations.

Punjab.—The seeds were sown in a nursery bed 6 ft. × 3 ft. on 11th April, 1941, at Manali (elevation 6,000 ft.) in drills 6 in. apart and watered by percolation. Germination commenced on 5th May, 1941. The seedlings were shaded from the sun. Germination per cent. was 17. By 8th November, 1941, only 28 seedlings survived, the rest having died due to cock-chaffer attacks.

In August, 1942, 21 seedlings were pricked out to 2 ft. × 2 ft. Seed was collected from the plants from July, 1942, to end of March, 1943. All plants are reported to be doing well.

The collected seed was sown in 3 nursery beds on 11th of April 1941, but germination per cent. could not be determined. 186 seedlings were obtained by July, 1942; 70 seedlings survived. Seed collected from these plants was again sown in 2 boxes on 7th August 1942. Germination per cent. was 48.

N.W.F.P.—The seed was sown in pans. The plants were reported as doing well in September, 1942, but by March, 1943, the results were reported as disappointing, after germinating well and doing well in early life.

The agriculture department, however, are able to make a success of the job at Peshawar as they were able to spare up to 10,000 plants @ Rs. 30 per 100 exclusive of packing and freight.

Baroda.—The seed was sown at Salher (elevation 3,300 ft., Max. Temp. 98°F., min. 50°F., rainfall 90 to 100 inches). Only 5 plants were obtained from ½ ounce seed.

690 seedlings were, however, obtained from Kenya seed.

Mayurbhanj (*Eastern States*).—Seeds were sown in the nursery at Dhuruduchampa, Simlipal hills (elevation 3,300 ft., rainfall 80 inches) and resulted in 50% germination. Flowers were collected in April, 1940, and found t have a *pyrehrin* content of 1.158% which is stated to be quite a high figure.

20 lbs. of seed was obtained through the Imperial Council of Agricultural Research to plant up 20 acres of land in the Simlipal hills.

Since the above notes were compiled Madras has successfully planted out some 2,000 acres of *pyrethrum* in the Nilgiris and in the plains. A fair proportion of the plants is already in flower. It is understood that the Divisional Forest Officer of the *Pyrethrum* Division is writing up the details of this big project as a bulletin.—*Ed.*

EFFECT OF DIAMETER OF TEAK STUMP USED ON SURVIVAL PERCENTAGE AND EARLY HEIGHT GROWTH

The Central Silviculturist has sent us the following account of an experiment carried out in the Bori forests by the Divisional Forest Officer, Hoshangabad, on the effect of the diameter of teak stumps on survival percentage and height growth.

The experiment is of interest in that it confirms the results of the original experiments in Madras. It is noticed that the design of the experiment is symmetrical and modern practice is the avoidance of any lay-out with a tendency to bias.

The relatively small height growth at the end of the first growing season is probably due to late planting, *viz.*, June 21st, and to an abrupt termination of the monsoon.

Stumps over half an inch in diameter show an increased survival percentage of 15 per cent. and an increased height growth of over 100 per cent. compared with stumps of smaller diameter.—*Ed.*

Locality.—Compt. 14 Bori, Hoshangabad division, C.P.

Area: 0.4 acres.

Situation: In part of the 1943 plantation formed by normal plantation practice.

Lay out: 20 plots each 8 × 3 stakes at 6 ft. 6 ft. espacement arranged:

E_1	A_2	B_3	C_4
D_1	E_2	A_3	B_4
C_1	D_2	E_3	A_4
B_1	C_2	D_3	E_4
A_1	B_2	C_3	D_4

Stock used: 1-year-old stumps raised in Hiranchapla nursery from weathered Bori seed collected in 1941.

Treatments—

A Stumps 0.3 to 0.4 in. diameter.
B Stumps 0.4 to 0.5 in. diameter.
C Stumps 0.5 to 0.6 in. diameter.
D Stumps 0.6 to 0.7 in. diameter.
E Stumps 0.7 to 0.8 in. diameter.

Date of planting: 21-6-43.

Tending: Two weedings were done, the first from 22nd July to 3rd August and the second from the 9th to the 23rd of September. No casualties were replaced.

Measurements: The plots were enumerated and heights recorded on 12-10-43 at the end of the first growing season after planting. A check measurement on 10-12-43 showed that no appreciable growth had taken place since the measurement on October 12th.

Results: Measurements on 12-10-43 at the end of the first growing season after planting showed:

Treatment.	Size of stump.	Survival percentage.	Mean height growth in inches.
A ..	0·3 to 0·4 ..	79	6·2
B ..	0·4 to 0·5 ..	86	7·5
C ..	0·5 to 0·6 ..	84	9·5
D ..	0·6 to 0·7 ..	93	11·1
E ..	0·7 to 0·8 ..	95	12·5

These data were analysed statistically with the following results:

I. *Survival percentage.*—At the end of the first growing season after planting:

A—B	...	Significant (5% level).
A—C	...	Not significant.
A—D	...	Significant (1% level).
A—E	...	Significant (1% level)
B—C	...	Not significant.
B—D	...	Not significant.
B—E	...	Significant (5% level).
C—D	...	Significant (5 % level)
C—E	...	Significant (1% level).
D—E	...	Not significant.

II. *Mean height growth.*—At the end of the first growing season after planting:

A—B	...	Significant (1% level).
A—C	...	Significant (1% level)
A—D	...	Significant (1% level).
A—E	...	Significant (1% level).
B—C	...	Significant (1% level).
B—D	...	Significant (1% level).
B—E	...	Significant (1% level).
C—D	...	Significant (5% level).
C—E	...	Significant (1% level).
D—E	...	Significant (5% level).

Discussion.—In Bori the main difficulty in teak nurseries is to get the stumps big enough for planting in one year. The main practical data, therefore, concern the smaller sizes rather than the larger sizes.

The above results show that, as far as the end of the first growing season, the plants raised from stumps of 0.3 to 0.4 in. diameter give significantly inferior survival percentage and mean height growth when compared with stumps of size classes from 0.4 to 0.8 in. diameter.

The stumps of 0.4 to 0.5 in. diameter resulted in a significantly inferior height growth when compared with stumps of 0.5 to 0.8 in. diameter but their survival percentage was not significantly inferior.

The survival percentage and mean height growth of the stumps of the 0.5 to 0.8 in. diameter classes were sufficiently good to ignore further comparisons though in this class generally the bigger the stump the better were the survivals and height growth.

Conclusions.—The experiment is a first experiment in a new locality and it has only gone through one growing season. It needs to be carried on until the significant differences disappear, or until the first thinning, whichever is earlier. It also needs confirmation by repetition.

It, however, gives the preliminary indication that (under the conditions of the experiment) it is probably not worthwhile to use stumps as small as 0.3 to 0.4 in. diameter and better not to use those of 0.4 to 0.5 in. diameter if larger sizes are available.

Note.—This is interesting confirmation of results obtained in Madras and published in *Indian Forest Record (New Series) Silviculture, Vol. III, No. 5.* It appears that the effect of diameter of stump is even more pronounced under Bori climate conditions than under Madras conditions.

A NOTE ON THE SILVICULTURE OF *CHLOROPHORA EXCELSA*

By Y. M. L. Sharma, M.Sc., A.I.F.C.,

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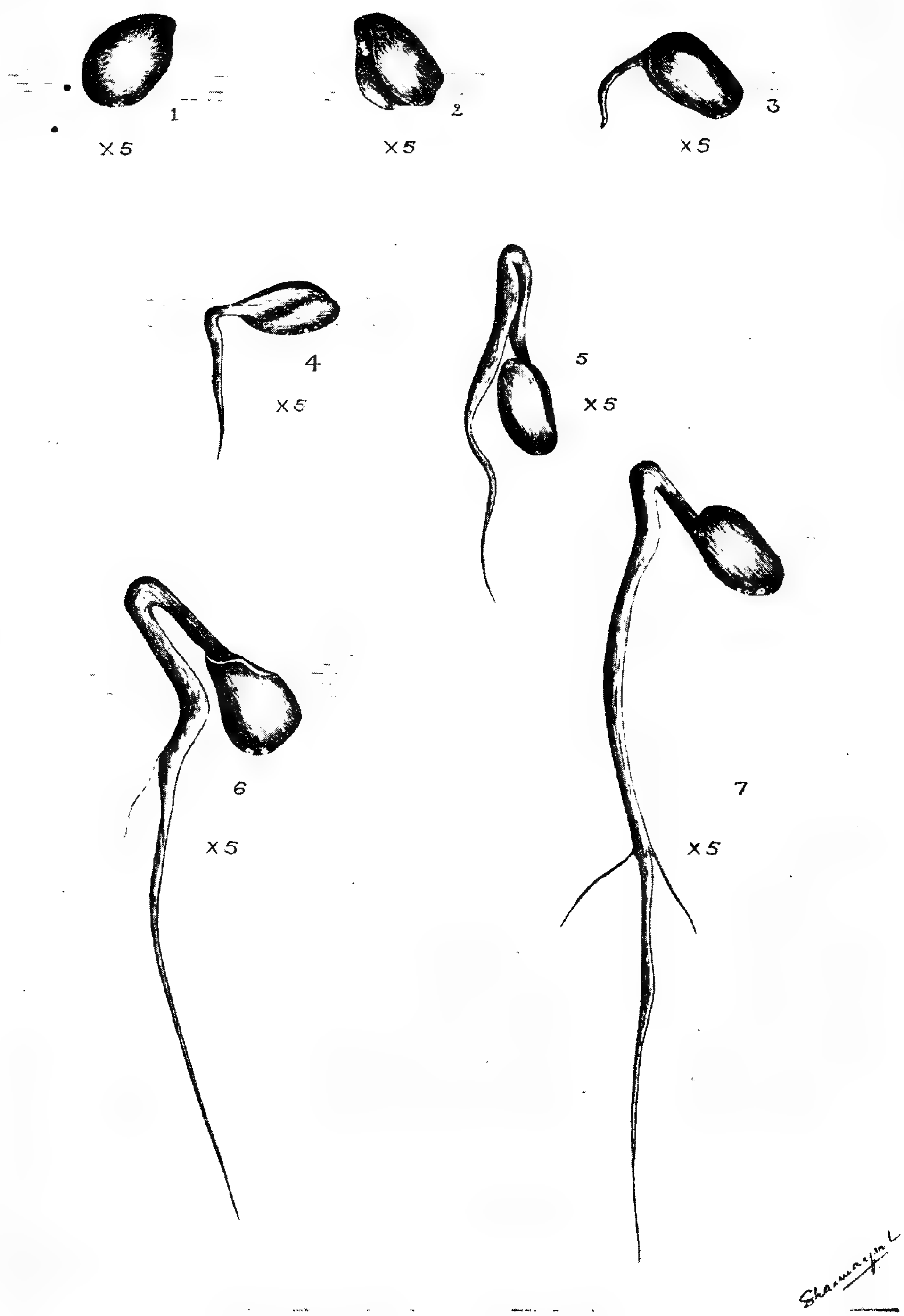
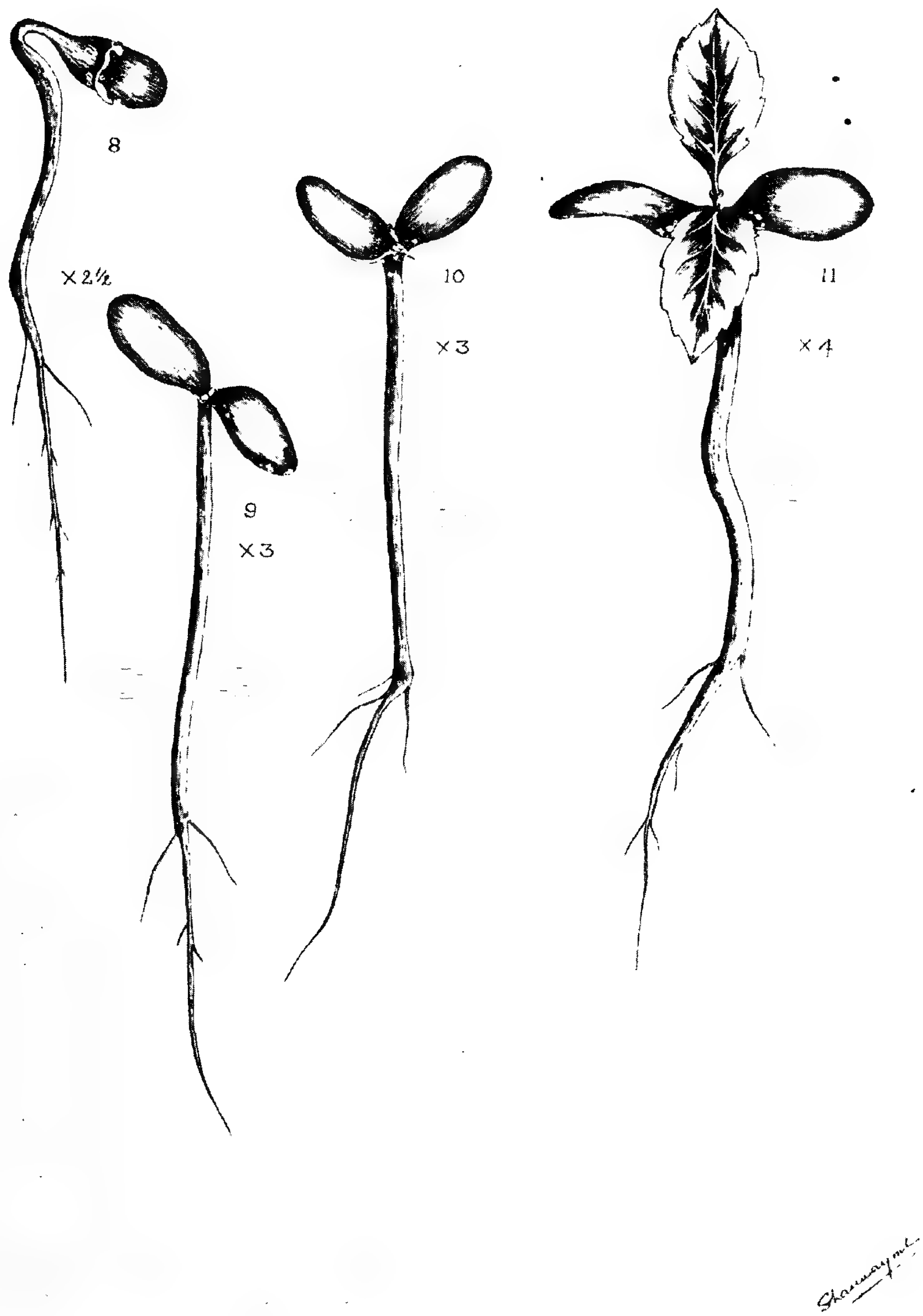
Distribution and habitat.—Chlorophora excelsa (Muvule) is an exotic in India. It is indigenous to Uganda and the suburban territories. It is a large deciduous tree found in the virgin rain, and mixed deciduous forests, and to a large extent in the savannahs in its home. The tree attains a height of 160 feet in the forest, with a clean, straight, cylindrical bole of 50 to 80 feet high, while it reaches about 100 feet in the savannahs. It has a large crown with a few stout spreading branches, the ultimate branches pendulous.

CHLOROPHORA EXCELSA



CHLOROPHORA EXCELSA



The surface roots are well developed, the stem reddish-brown, with conspicuous yellow lenticels.

Its introduction to India is very recent, dating back only five or six years. It has been tried in the Presidencies of Bengal, Madras, and Bombay and in the Andamans. In Madras it has been tried at Kannoth, Begur, Chandanathode and Nilambur.

Leaf fall.—The leaf fall in Uganda is reported to occur during January and February and the trees are leafless for only a month or a little more. The plants are dioecious and the sexes cannot be distinguished until the trees put forth flowers and fruits. The fruits are compound and aggregate like mulberry with plenty of pulpy material. The seeds are dispersed mostly by birds.

Germination.—The seeds are very small. The germination has been tried all over India. Seeds received from Uganda by post stood the transit well. In Dehra Dun, germination is poor probably due to frost, while in Madras the germination and plant per cent. are very high.

Pre-sowing treatment of the seeds has been tried sometimes, viz. (*i*) leaving the seed in hot water until the water cools down; (*ii*) boiling water; and (*iii*) soaking the seed in cold water for nearly 24 hours. The results seem to show that there is not much difference between the treated and untreated seeds in their germinative capacity. The smallness of the seeds necessitates the formation of raised nursery beds, the earth thoroughly dug deep and well worked, for the seedlings have good tap roots. It is said that light shade is beneficial to germination.

The germination starts within a week after sowings are done. The different stages of germination were studied in detail by the writer, practically, in the F. R. I. nurseries during the rains of 1941 (*vide plates 6 and 7*).

Germination is epigeal. The radicle emerges by breaking open the testa as a small protruberance at the micropylar end and gradually grows downwards. The hypocotyl is fairly long and carries with it the two cotyledons above the ground. The seed coat persists until the cotyledons are just to appear above the soil, or slightly before. The plumule in between the cotyledons develops into a pair of opposite leaves. The cotyledonary leaves are ovate to ovate-lanceolate in shape. They persist until a second pair of leaves develop decussately arranged with the cotyledonary pair, and then shrivel up. The true leaves are ovate, ovate-lanceolate or lanceolate in shape and the margin dentate or sometimes serrate.

Silvicultural characters.—*Chlorophora excelsa* has the characteristics of a strong light demander like *teak*, although it is said to need slight shade in its first year. It is frost-tender as shown by the fact that it has not been able to thrive successfully at Dehra Dun due to the prevalence of occasional frosts in the area. It loves deep soils, seeks out moisture and hates dry regions. The capacity for coppicing and forming rootsuckers extends up to trees of fairly large diameters.

Natural Regeneration.—It is said that *Chlorophora excelsa* can regenerate itself naturally well in the savannahs at a high altitude, and natural regeneration is said to come up very well in Uganda in occasional and accidental gaps and areas of abandoned cultivation. Natural regeneration is ephemeral under a complete canopy. Regeneration grows well in complete open canopy, but also grows well if shade is not too dense. Usually natural regeneration is supplemented by broadcast sowings.

Artificial Regeneration.—Artificial regeneration by sowings, transplanting one-year-old seedlings, stump-planting and other methods seems to be more successful than natural regeneration.

In Uganda natural sowings are said to establish with sufficient light in the soil. Stump planting and planting in strips have been tried successfully and the latter method tried to maintain the continuity of the forest and the young trees are raised similar to natural conditions. In Uganda green manure is applied to the nursery beds. The seeds are sown mostly in lines or sometimes broadcast.

Pricking out is done when the plants are in four leaves, 10 to 25 cms. apart. The plants are kept in the nursery for one or two years and the stumps are said to give 74 to 88 per cent. success at two years. Transplanting of year-old seedlings is done and interplanting with boga is tried. In Madras, direct sowings on the Wynaad plateau in natural teak areas with an altitude of 2,000' to 3,000' and rainfall of 60" and 300 altitude and a rainfall of 120" have given poor results due to the small size of the seed. (Exptl. plots 54 at Begur and Plot 62 at Kannoth).

Transplanting one-year-old seedlings, stump-planting with stumps of two-year old seedlings from nursery and planting shoot cuttings have all given good results at Begur and other places but stump-planting seems to be the best method. Stump-planting one-year-old stumps under a top-canopy cover and after clearfelling have been tried at Chandanathode in 1938 and the species is doing better in mixed deciduous forests than evergreen.

Injuries.—The species is frost-tender and very suscepible to cold.

The young seedlings, saplings and poles are susceptible to the attack of *Phytolyma lata* (Scott), a gall-forming insect and the damage done is considerable and, to prevent this, a satisfactory method of regeneration of the species is yet to be found. But it is said that shade reduces the frequency of attack by the insect.

Browsing by deer is another important danger to the crop to be considered. Fencing the whole plantaion and individual plants appear to have been tried in Uganda but they have not been successful in this line for the local people are averse to it. Fencing, too, seems to be unpopular in Africa; plants six feet or more are more or less immune to browsing and sometimes the plants are masked in the evergreen weeds and shrubs. But browsing is a very serious trouble in clear, unfenced and weeded areas for, when once the weedings are done, the plants stand out very conspicuously to deer.

Utilization. The timber of male and female trees is very similar. The sapwood is yellow-white, sharply defined, 1 to 2 inches wide, heartwood yellow to yellow-brown when freshly cut, darkening into deep golden brown or russet brown with lines of paler tissue, sometimes marked with darker streaks becoming deep-brown if repeatedly oiled or if treated with lime. The wood is valuable in hardness and weight, fairly coarse in texture with a typically interlocked, sometimes wavy grain. It is odourless and tasteless. The wood of male trees is slightly denser than that of female trees and is difficult to saw. The timber cuts fairly easily and clearly with suitable types of saws and it planes with moderate ease to a smooth finish when flat-sawn, although the interlocking grain causes quarter-sawn timber to pick up to a considerable extent. It has 12 per cent. of the dulling effect of teak on cutting edges planed under identical conditions. The timber moulds fairly easily and readily, male trees giving the best results, bends moderately, nails well and takes a fine polish. The best finish for the timber is its natural colour with a wax polish. The weight is 40 to 45 lbs. per c. ft. air-dry and 63 to 68 lbs. per c. ft. when green.

The tree is of great importance as the timber tree of Uganda. There is a a strong local demand for the timber and it is the first choice of the African and European carpenters due to its lasting qualities and attractive appearance.

Uses.—The timber of *Chlorophora excelsa* is used for constructional purposes for portions of permanency and high strength. Beauty makes it useful for furniture but it is heavy for the purpose. The timber is termite and teredo-proof, resistant to water, and exceptionally so to fungal attack. Thus it is used largely for railway-wagon workshops, floors and shipbuilding in Europe. It is recognised by the London County Council as fire-resistant. Logs give large sawn material and these have slight tendencies to warp and split. Sawn material from five typical logs sent for test from Uganda to the Forest Products Research Laboratory, Princes Risborough, gave exceptionally satisfactory yield of first-quality timber when graded in accordance with the grading rules and standard sizes for Empire hard-

woods. Yield from one log in the consignment was cut from a dead tree and the quality of its timber was noticeably superior to that of the other logs both in respect of the sawn finish and in case of sawing. This suggests that girdling of standing trees some years before felling leads to the production of better timber.

Because of its value "Muvule" is perhaps the most widely-planted species in Uganda, but owing to the fact that the young trees are nearly always attacked by the gall-forming insect, and are heavily browsed by all game, a really satisfactory method of regeneration is yet to be found. In west Madi the fruits are said to be articles of diet and the juice extracted by pressure is used to flavour porridge.

The plantings done experimentally in S. India are giving good results and the future of this species is very hopeful to replace the blanks created in our natural teak forests.

The writer is grateful to Mr. E. C. Mobbs, Principal, Indian Forest College, for helping him in conducting the nursery work and the Forest Botanist and the Central Silviculturist, Dehra Dun, for allowing him to collect information about the species from their libraries.

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THE AFFORESTATION OF SHANKARACHARYA HILL

BY A. A. FIRDAUS.

(Divisional forest officer, forest research division, Srinagar, Kashmir)

More than twelve years ago the Shankaracharya hill near Srinagar was handed over to the forest department for afforestation with a view to improve the æsthetic outlook.

It is a small hill with an area of about 350 acres, representing all aspects of the compass. Elevation 5,200 ft.—6,500 ft. Parent rock hard sandstones and shales, seen in the outcrops on many faces.

Soil.—Except in a few places on the northern aspect where it is somewhat deep, the soil on the rest of the hill is extremely shallow loam with stones of parent rock in great abundance.

Vegetation.—The area has been subject to heavy grazing in the past. A small patch of *P. excelsa* exists in one place comprising about 300 trees. The area when taken over by the department in the year 1930 was absolutely bare and devoid of any tree growth. It remained partially closed to grazing for about six years but later on it was completely fenced. After the closure quite a large number of pine seedlings have appeared here and there on the northern aspect. The following shrubs have also made their appearance:

Cratgus oxyacantha, Rosa macrophylla, Berberis lycium, Zizyphus vulgaris, Rumex hastatus, Plectranthus rugosus, etc.

Climate.—Average annual rainfall is about 27 in. of which 60 per cent. falls during December to May. Snow falls during winter (December—February) and severe frosts are common. Maximum temperature during summer seldom exceeds 100° F. in the shade. Relative humidity is generally quite high, the least being 65—70 during June-July. The climate and broad distribution of rainfall resemble more or less the mountains along the Mediterranean except for the snowfall. Unlike the rest of India there is little or no monsoon rain during summer. The summer months, June, July and August, are very hot and dry and most of the casualties in the planting operations occur during this period on account of severe drought.

During the first five years, *i.e.* 1931—1935, no systematic work was done on the hill. The usual practice was to import plants from outside (territorial nurseries) and to plant them at a spacing of 12 ft. × 12 ft. in deep pits. The planting was done late for fear of frost and continued some time into June. The results were absolutely hopeless.

Systematic work was started in the year 1936 by my predecessor (Th. Harnam Singh, now deputy chief conservator of forests). He established nurseries at Srinagar and organised them on scientific lines and did much work in selecting the right species for the locality. The first thing that he did was to start early planting so that the planting operations were complete by the middle of April. The planting distance was reduced to 8 ft. × 8 ft. He remained in charge of this work from 1936 until 1940. Except during the year 1936 when the weather conditions were marvellous in that the rain was quite above the average and well distributed over the whole summer, the following three years were marked by deficiency of rain, with the result that the success obtained with pit planting, the only method that was adopted at that time, was far below expectations. The rain during these years was far below normal—there was hardly any soaking rain. What looked quite fresh and promising in the early summer was destroyed to a very great extent by the subsequent drought. Even what survived did not look happy.

During 1940 Shankaracharya park was transferred to the research division and in the following year the writer started the work of contour-trenching under the advice and guidance of Sir Peter H. Clutterbuck (C. C. forests). Extensive contour-trenching on the "Gradoni" system was done all over the hill during the years 1941 and 1942. More than 15 miles long contour trenches, 24 in.—30 in. wide, and 18 in.—20 in., deep, were constructed during these two years. Almost all the species, both conifers and deciduous, were tried in these trenches. Though no comparative results of pit and contour-trench planting are available, yet the results obtained with contour-trench planting have been most remarkable and beyond any expectations. All species planted out in trenches showed not only a much higher percentage of survival but, at the same time, exhibited more vigorous and faster growth as compared to the pit plants. Though all species were found more or less equally happy in the trenches, the following showed exceptionally good results as regards their height, growth and crown formation:

(1) *Robinia.*
(2) *Ailanthus glandulosa*
(3) *Morus alba*
(4) *Deodar*
(5) *P. excelsa*
(6) *Pinus halepensis* } Exotics.
(7) *Pinus canariensis* } Exotics.
(8) *Pinus longifolia* } Exotics.
(9) *Cupressus arizonica* } Exotics.
(10) *Melia azedarach*

The results obtained so far indicate that contour trenches are most efficient in holding up larger quantities of rain water and snowfalls and preventing soil wash. Increased growth of grass and weeds between contour ridges testifies to their effect on soil improvement and better height growth illustrates the greater water storage capacity.

This method compares most favourably with pit-planting, the ordinary method which was mainly used formerly. The percentage of survival is greater at least by 15 % under favourable weather conditions, otherwise it would be greater by 50%.

There is no doubt that contour-trenching is more expensive as compared to pit-planting but the results obtained indicate that it is the cheapest method in the long run. What could not be done with pit-planting during the last 10 years has been achieved within two years with contour-trench planting. Of course we have not experienced severe droughts during the years 1941 and 1942 but I still have reason to believe that most of the success of our planting operations is largely due to this method of site preparation, *i.e.*, contour trenching. In a year or so, comparative results on scientific lines will also be available.

NOTE ON THE ABOVE

By W. D. M. Warren, I.F.S.
Divisional Forest Officer, Santal parganas Division, Bihar.

While recently on leave in Kashmir I was surprised and delighted to come across examples of afforestation with the aid of the "Gradoni" (Italian) system of contour trenches.

In advocating the use of trenches in India in the past, I have always visualised their chief use to be in places of extremes of heat down in the plains, but apparently trenches can be usefully employed even in Kashmir at a height of 5,000 feet, where maximum temperatures "rarely rise above 100° F." With a rainfall of only 27 inches one can readily understand, even here, the need of saving every drop of runoff for the benefit of the forest crop. I can myself testify, too, as to the extremely dry crumbly nature of the soil on the Shankaracharya hill.

This is indeed a very interesting experiment. If it succeeds as it appears to be doing, it will change the whole aesthetic appearance of the Shankaracharya hill from its present greeny brown bare appearance to the deep greens of well-wooded slopes. Will the artists, who have painted the Dal lake with the temple-topped hill in the background—a popular subject with them—still be as pleased as before? I think so. I am not an artist, but I should imagine the dark-greens to be just as satisfying as the present colours. They certainly are to the forester. For whereas the present colours depict barrenness and sterility the new deep-greens will suggest satisfying fertility as well as useful firewood and building material for Srinagar itself.

After the temple hill has been afforested, will afforestation rest there or will it be encouraged to tackle the other ranges of hills beyond the palace to the north rising as a 3,000 foot fringe above the Dal lake? Perhaps part of those hills, at any rate, will be left to show visitors what the hills looked like originally, before the forest department beautified them?

Mr. Firdaus states that comparative results on scientific lines will be available within a year or two. We shall await them with much interest, almost with impatience! For I am afraid that our comparative results on this most fruitful line of research are still pretty meagre! The practical forester wants to know:

(a) By how much, if any, mortality is decreased by trenching?

(b) By how much, if any, is the rate of growth increased—in height, diameter and total volume?

(c) Is trenching better than *boga-medeloa* or any other nurse-crop for afforestation work?

(d) Is trenching plus a nurse-crop better than trenching alone?

When we have answers to these questions for a variety of climates, soils, aspects and slopes, we shall be better able to assess the true value of trenching in afforestation work.

The snag is, of course, to find strictly comparable slopes of sufficient extent to lay out the experimental plots, if possible side by side or alternatively near to each other. Slopes may be right but aspects may be wrong, or both may be comparable but the soil may be different!!

Just before going on leave in 1939, I had thought I had discovered three areas which would satisfy the most exacting critic. In the one area, plots were laid out, the areas fenced and *gamhar* plants, of which we had plenty at the time, were carefully sized and planted out. Unfortunately, the very few deer of those parts discovered the plots, jumped the fences and ate up the lot!!

In a second case in another division an excellent area was found, unfortunately just outside the forest boundary!! The original owner had died. The new owner, though not cultivating the area himself, refused to loan us the land and so the experiment had to be abandoned.

A third area was left to the divisional forest officer to select and that apparently fizzled out too!! So if Kashmir can give us comparative results we shall be grateful. Even then, I imagine that no province will remain completely satisfied until it has its own results for each set of edaphic and climatic conditions.

EXTRACTS

THE AGE OF WOOD IS NOT PAST

Discussion of the future of British forestry takes place now, as it did 25 years or so ago, when our dependence upon timber is strikingly impressed upon the minds of all. The fact that timber is a truly vital necessity in time of war is everywhere acknowledged; it could not be otherwise with all the abounding evidence there is of its manifold uses, from the Mosquito bomber at one end of the scale to the humble packing case for army stores at the other. But there is need for the reminder that British history has provided equally striking examples of the importance of timber supplies produced on our own soil and that the lessons of the past have often been ignored once the immediate urgency that gave point to them has passed. The only times when forestry has prospered here, observes Dr. E. V. Laing in the current *Quarterly Review*, have been in and immediately after national emergencies, such as a war, when we had to depend on our own resources and we needed timber badly. He mentions the demand for oak at the time of the Armada, the similar urgent desire for trees and timber in the time of Napoleon, the call for home-grown timber in the last war, when many people said this would be the end of our apathy to tree growing. In the present war we are more than ever having to find our timber at home, and already we have the cry that forestry will have to develop out of all recognition in the years following the war so that never in the future will we stand a chance of being defeated through lack of this essential commodity.

Despite the lessons of the past, states Dr. Laing, there were many antagonists to forestry and they were able to carry a great deal of weight. He particularly refers to one argument invariably used, namely, that the age of wood belonged to the past. This, he avers, was a clear case of being misinformed or of failure to find out the truth, or refusal to see the true state of affairs. We may get a repetition of this, though with a lively Timber Development Association functioning, and the individual members of that organisation attuned to the task of placing timber and its service to the community in its right light, there should be less opportunity for headway to be made by these particular antagonists.

"The age of wood is not past and never will be, as a glance at the Board of Trade returns for the past several years would show," states Dr. Laing. "The quantity of timber coming into this country has been mounting." In the year 1937 we imported £70,000,000 worth of timber and wood manufactures. Some of the uses of wood have altered, but the need for wood persists and will persist. "We speak of ships no longer being built of wood. They are steel ships. Nevertheless in every ship there is much timber and timber is needed in its construction. In the luxury liners the percentage of wood is high. Even in a 10,000-ton cruiser there are 2,000 tons of wood. "Think of the newspaper, derived from wood—close on 1,000 acres of forest needed daily to make the daily papers of this country; or of the immense quantities required to manufacture artificial silk goods; of producer-gas for wood and charcoal for driving motor vehicles. The easy running of our railways is in no small measure due to the wooden sleepers. "Two thousand of these sleepers, each of 3 1/8 cu. ft. of timber, are needed for each mile of railway; this represents about three acres of first-class forest . . . . Despite its competitors, wood still remains popular for furniture. Wood is warm and beautiful and, unlike its rivals, the older it gets the warmer, more mellow and prettier it becomes. There is also endless variety in its texture and colour. It never tires!"

The answer to the question—is forestry essential to the future welfare of the nation,?—is, of course, unanimously in the affirmative. Dr. Laing invites his readers to imagine what would have happened now if the antagonists of afforestation had won the day in the years following the last war. If they had we could never have supplied the wood for making the

thousand-and-one things required in the modern warfare either by the Forces or by industry. Above all, how could we have supplied the pitwood so that we could get the coal for industry and household warmth, "for the wooden pitprop still reigns supreme despite concrete and steel rivals." We can almost say now, adds the writer, that the opponents of forestry were fifth-columnists of the worst type. "It is to be hoped that after the war they will not be able to raise their voices in the slightest without being dealt with as enemies of the nation."

Dr. Laing might have gone on to dwell on timber's necessary place in the great programme of reconstruction and building after the war; but he uses these observations quoted merely as incidental to a development of his ideas on forestry in the future—a subject which is being much discussed in Parliament and elsewhere just now. We single them out because they have a widespread interest for all in the trade at a time when the necessity for spreading the truth about timber and its service and about the adequacy of future supplies is so clearly realised and emphasised by responsible spokesmen of our trade.

—*The Timber Trades Journal,* Vol. CLXVI, No. 3490, dated July 17, 1943.

SOME PLANTS POISONOUS TO LIVESTOCK

By Narain Das Kehar, M.Sc., Sc.D.

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Poisoning of livestock may be caused either by some of the flowerless plants such as fungi, lichens, etc., or by flowering plants such as the gramineae and leguminosae. This article deals with plants of the second group only, inasmuch as they are more extensively concerned with the poisoning of livestock.

The history of poisoning by plants in India can be traced to the remote past. The earliest mention is to be found in the *Rig Veda*, which is one of the oldest repositories of human knowledge, while further details may be gleaned from the *Charaka Samhita* and the *Shushruta Samhita*. Although some poisonous plants are protected by an unpleasant odour, an acid or bitter taste or by spines, the poisoning of animals by such plants is of common occurrence, in spite of the widespread belief that they are protected by some instinct against eating dangerous plants. The important contributory factors incidental to poisoning are: (1) the ingestion of wilted, frosted or defoliated plants during drought, (2) the scarcity of palatable fodder during winter and early spring, (3) fatigue in transport and draught animals, (4) lack of salt, (5) a depraved appetite, (6) the fact that poisonous plants often grow in close association with palatable fodder, (7) the importation or transport of animals to new surroundings, and (8) the ingestion of poisonous plants along with hay.

Enormous losses.—It appears, therefore, that in a country such as India, where a balanced feed is rarely available to animals, where pastures are over-grazed and grazing grounds are infested with poisonous plants, an enormous percentage of the cattle population is exposed to the dangers of poisoning. It seems, however, difficult to obtain reliable figures with regard to livestock losses sustained by plant poisoning, as only those cases are reported in which a large number of animals are involved.

The annual loss due to plant poisoning in animals in the U.S.A. is estimated to exceed $200,000,000 and in some years they may be even greater. In one extensive outbreak in Texas, it was estimated that during one spring alone animals valued at $300,000 died from the effect of a single species of plant. Individual losses involving five to ten thousand dollars are not uncommon, while losses involving smaller amounts occur continually throughout the length and breadth of the country. Similar reports of heavy losses have been made in England, South Africa, Australia and Germany.

The death of stock is not the only loss caused by the poisonous plants; consequent losses may be manifested in the form of : (1) a drop in milk yield, (2) the loss of milk and flesh, (3) the loss of milk and wool in sheep, (4) the loss of condition in horses, (5) losses due to the action of poisonous plants on the foetus, causing either its expulsion as a result of the contraction of the uterus or its death, (6) sterility, (7) losses due to temporary or permanent injury to different organs, such as the heart, gastro-intestinal canal, kidney, liver, salivary glands and the eyes, (8) disturbances in the processes of metabolism, and (9) deformities in hoofs.

Hydrocyanic acid producing plants.—It is not to be expected that the losses due to plant poisoning are less in India than in the other countries mentioned above, especially as the plants incriminated in other countries also exist in India. According to the work of Chopra and Badhwar, at least 700 poisonous plants are known to exist in India even at the present day. It appears that the reason why stock poisoning cases are not brought to the public notice is that in all probability a very large number of cases and even outbreaks of plant poisoning pass unrecognized and thus remain uninvestigated.

It is not possible to deal with the large number of plants that are poisonous to stock but brief mention will be made only of poisoning due to some of the important hydrocyanic (prussic) acid producing plants, which form a major portion of the food of animals and are highly relished by them. *Sorghum vulgare* Pers. (*jowar*), *Sorghum halepense* Pers. (Johnson grass, *dadam*), *Sorghum vulgare sudanese* L. glax. (Sudan grass), *Triglochin maritimum* Linn. (arrow-grass), *Trifolium repens* Linn. (white clover) and *Zea mays* Linn. (maize) ordinarily form nutritious fodders, but under certain climatic and soil conditions, especially in times of drought or when the plants are wilted, stunted or young, they develop dangerously large quantities of hydrocyanic acid, which is highly poisonous to all stock.

It is a common practice to put stock out to graze cut-over fields in the late summer and autumn and the regrowth is much relished by the animals on account of its succulent saline character and its freedom from stems. Herein, however, danger lies, since they are very rich in hydrocyanic acid.

In practical feeding, therefore, young seedlings under one foot, plants stunted owing to drought and second growths or ratoons and secondary shoots should be avoided.

It has been observed that under conditions of drought the hydrocyanic acid content of some of the crops increases to about $2\frac{1}{2}$ times the original quantity. Wherever possible, either the forage affected by the abovementioned conditions should be thoroughly cured or converted into silage with water added to ensure fermentation since it is believed that ensiling renders the hydrocyanic acid-containing plants innocuous.

Feeding animals on different species of acacia is also a common practice and it is pointed out that although, as a general rule, there is little risk of poisoning as a result of the consumption of mature pods, the fresh green foliage, twigs and green pods are said to be harmful at times owing to their containing hydrocyanic acid.

Linseed cake has been found to produce prussic acid poisoning and in order to destroy the enzyme or ferment responsible for liberating the hydrocyanide from the glucoside, the cake should be treated with boiling water. The cynogenetic glucosides are widely distributed in plants and hydrocyanic acid has been found in 148 species of 41 families.

The chief symtoms of hydrocyanic acid poisoning are accelerated and deepened respiration, weak and irregular pulse, increased salivation and frothing at the mouth, muscular twitching, staggering as if intoxicated, anxious expression, dilatation of the pupils, convulsions, coma and death due to respiratory paralysis.

Treatment.—Preventive. When climatic conditions are most favourable for hydrocyanic acid poisoning, sulphur should be fed to livestock as follows:

Two tablespoonfuls of sulphur for cattle per head per day and one teaspoonful to sheep and goats every fourth day.

Curative.—Because of the rapid course of hydrocyanic (prussic) acid poisoning, it is necessary to apply the treatment without delay. Bleeding is sometimes useful in removing large quantity of absorbed hydrocyanic acid and this should be followed by intravenous injections of 10 c.c. of 20 per cent sodium nitrite solution and 30 c.c. of 20 per cent sodium thiosulphate for cattle, and a half of this dose for sheep.

Simple Tests.—A working guide as to the poisonous nature of the fodder may be the application of the following tests:

(1) Strips of filter paper are dipped in a saturated solution of picric acid and dried in air. The leaves of the suspected plant are macerated, preferably by adding a few drops of chloroform, to effect the release of hydrocyanic acid from the plant cells. The macerated plant material, which may have in suspected cases the odour of bitter almonds, is placed in a small bottle. When the picric acid filter paper strips are moistened with 1 per cent sodium carbonate solution and inserted with the cork in the bottle they will show the presence of hydrocyanic acid by changing colour to orange and finally to red.

(2) Cut a transverse section of the stem of a suspected plant near the root, and add a small amount of tincture iodine. The changing of the cut surface to blue or black indicates the presence of hydrocyanic acid.

Enough has been said in this brief survey to indicate that the losses due to fodder poisoning in India must be enormously greater than official records would suggest. It is, however, realized that in a country where animal foodstuffs are extremely scarce and where the average farmer is forced by poverty to rely mainly on grazing for the feeding of his cattle, complete abstinence from the only fodder available at certain seasons is scarcely practicable. —*Indian Farming*, Vol. 4, No. 3, March 1943.

NO WOOD, NO SHIPS

The modern navy is as much dependent on the output of the sawmills as were warships of a couple of centuries ago. In the words of Rear-Admiral C. H. Woodward, U.S.N., Chief of the Incentive Division, one cannot fight a war, much less carve out ultimate victory, without wood. He quotes some eye-opening figures clearly showing the prominent part taken by timber in all spheres of naval construction.

Wood a Basic Requirement.—To prove this contention, Rear-Admiral Woodward states, in an article in *The Mississippi Valley Lumberman,* that a glance at some of the types of naval craft, for which wood is a basic requirement, will establish the indispensability of this material. Wooden landing vessels and assault craft formed the spearhead of the successful North African and Sicilian invasions. Wooden sub-chasers and Coast Guard cutters are playing a smashing role in the fight to overcome the U-boat menace. The wooden mosquito boats of Lieutenant-Commander John Bulkeley's squadron alone sank three Jap cruisers, two cargo ships, a tanker, two barges loaded with troops, and downed four planes; and these tiny craft continue to inflict severe damage on the enemy from the English Channel to the South Pacific.

As Rear-Admiral E. L. Cochrane, chief of the Bureau of Ships, points out, wood is also the bone and substance of cargo and passenger transports, floating dry docks, harbour patrol boats, mine layers, mine sweepers, submarine tenders, destroyer tenders, river gunboats, repair ships, crane ships, auxiliary ammunition ships, tugboats, submarine rescue vessels, hospital ships, oil storage barges, oilers, aircraft rescue boats, plane personnel boats, plane re-arming boats, buoy boats—the list could be extended indefinitely.

Even monster steel-hulled battleships require vast quantities of wood—over 300,000 board feet each for decking alone. Nor can construction work on them be conducted without wooden shipways and scaffolding. For an aircraft carrier, like the new "Lexington," over

250,000 feet of edge-grain Douglas fir must be provided for the flight deck. In each sub-chaser goes a quarter of a million feet of lumber for keel, frame, hull and decking. Seven different kinds of wood help to impart the lightness, speed and manoeuvrability for which the P.T. boats are famous.

A warship is born in a wooden mould loft, on which full-scale basswood models of all the ship's parts are laid out. Before a single plate is fabricated there must be wooden template to serve as a pattern. Even such mechanical units as steam engines are first patterned in wood, not to mention the numerous metal castings for other important components.

What all this means in terms of lumber requirements during the next crucial months can best be ascertained from the over-all picture of current naval expansion. According to Secretary Frank Knox, by the end of 1943 the navy expects to complete more combatant ships—exclusive of auxiliaries, mine, patrol and landing craft—than there were fighting ships in service at the end of 1942. The number of warships in the fleet will thus be doubled in a single year. Since experience has shown that the cheapest way to build a ship is to repair one already built, a half billion dollar naval dry dock programme is under way. A single mobile dry dock for salvage or reconditioning of vessels far from home waters may require nearly 1,000,000 board feet of lumber.

The Bureau of Yards and Docks, which has supervision of this programme, also handles construction of all public works and utilities at naval shore establishments, and has undertaken additional shipbuilding and repair units. In fact, it is estimated that the Bureau —exclusive of other Bureaux regularly making extensive lumber purchases—will need for the various projects under its cognisance over a billion and a half feet of lumber this year. From December 7, 1941, to June 30, 1943, the Bureau utilised the stupendous total of 3,020,926,000 bd. ft.

For Fighting Planes.—The navy plans to treble its number of fighting planes during 1943. In this programme also, lumber is a critical factor. Rear-Admiral Dewitt C. Ramsey, chief of the Bureau of Aeronautics, states that great numbers of training planes, many of them of wood frame and plywood construction, are necessary to train the thousands of new navy, marine and coast guard pilots being developed to man the 27,500 aircraft which Congress has authorised for this branch of the service. Furthermore, this programme involves large-scale construction of such shore-based facilities as hangars, airfields, field repair shops, utilities, barracks and classrooms—all premised upon adequate supplies of wood.

Having briefly outlined other naval uses of wood, the writer refers to the growing need for crating material, giving conservative estimates that the navy and other war agencies will require an increase of over four billion board feet this year for containers, if oversea delivery schedules are to be met.

That is why the armed forces regard the men in the 30,000 to 40,000 lumber-producing units in the United States as front-line fighters in this conflict. Every skilled job in the woods and mills is, in every sense, a battle station, concludes Rear-Admiral Woodward. —*The Timber Trades Journal,* dated November 6, 1943.

INDIAN FORESTER

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YOUNG TREES AND *PHASSUS* BORERS (LEP., HEPIALIDAE)

By J. C. M. GARDNER

Forest Entomologist.

Introduction.—My own short experience with *Phassus** borers dates back to 1923, when, as an attached officer in Darjeeling, I visited the plantations in the division. In all these plantations, of several tree species, a high degree of attack by two kinds of lepidopterous borers was conspicuous: the families concerned were Hepialidae (*Phassus*) and Cossidae (*Zeuzera*) and it is the first of these that is now discussed. I was able to collect a number of stem specimens with living larvae which I took with me on my transfer to Dehra Dun and from which four or five species of *Phassus* and one of *Zeuzera* (*multistrigata*) emerged. I also tried some small scale experiments in control, with success in the case of *Phassus*. Since the control of these borers appears to be of considerable importance, and requests for advice are frequent, especially from south India, a brief summary of the known facts is now given. There are a number of gaps in our information which can only be filled by more observation. The main point is that the control measures advocated are successful and are applicable to all damage by *Phassus*.

Habits of Phassus.—The female moth, which is large, with a wing expanse up to 154 mm., lays a great number of very small eggs: one of my specimens laid 3,725 while a Japanese observer records 5,000 for another species; there must be enormous wastage. It is possible that these eggs are broadcast from the air, and that the young larvae climb the stems from the ground. Whether the young larvae enter the stem at once or have another habit I do not know; I found no very small tunnels but may have overlooked them. At some stage the larva enters the stem and bores a vertical tunnel up or down the centre of the stem (apparently according to the species); the tunnel varies in length, which may be up to 20 in. or so, and may enter the root. The entrance hole, normally the only one, causing the tunnel to be a cul-de-sac, is covered by a matting of wood fragments and frass bound with silk. Under this camouflage, which is extended as required, the larva feeds on the soft external tissues of the stem, retreating tail first into the tunnel when disturbed. The larva lives in stems of from about 3/4 in. to 5 in. diameter; in the case of thin stems the external feeding causes a complete girdle: above the girdle the stem tends to swell and callus and adventitious roots may be formed. The usual result is death of the top. Whether the larva uses any part of the inner wood for food is uncertain, but the camouflage always contains a good deal of merely bitten off wood from the tunnel, which is kept quite clean.

When full fed the larva pupates in the tunnel; the pupa is mobile and when mature wriggles partially out of the aperture and the moth emerges through the camouflage (which except for a gap looks very much as before).

So far as is known only young trees are attacked and then not far above ground level, varying in my experience from the collar to 8 ft. up the stem. There may be several sites of attack in one stem.

*The Hepialidae have been recently revised by Tindale, whose paper has not been received. The several species covered by this paper are referred to as *Phassus* for brevity although it appears they belong to the genera *Endoclita*, *Sahyadrassus* and *Palpifer*.

Distribution.—Phassus is common in the oriental region and has been reported as a pest in Japan, Java, Sumatra, Burma and Ceylon. In India attack is common in the Himalayan regions of Bengal and Assam and in Bombay, Madras and Coorg. Certain species are recorded from the hills of the Punjab and United Provinces but we have no attack records.

Economic importance.—The list of recorded host plants is very long and it is probable that few woody species are immune; however *Cryptomeria japonica* (in Darjeeling) is, I think, the only conifer recorded; in the last case attack is associated with precocious flowering. In Darjeeling attack was most serious on *Alnus nepalensis* (up to 72 per cent), *Machilus edulis, Eucalyptus* spp. and *Cryptomeria*; in south India (where *Phassus malabaricus* is the usual species) attack on teak, among numerous other species, is common. The young plants either die outright or the stem above the girdle dies and re-stocking of the gaps is necessary; in the case of teak however, it appears that a new leader is readily produced from the stump. In a few cases I was able to detect heart rot in large trees, traceable to *Phassus* attack of about ten years before; this aspect requires more investigation.

Diagnosis.—Since the control measures described below apply to *Phassus* but not to *Zeuzera,* another common borer, it is necessary to ensure recognition, a simple matter.

(*a*) *Phassus* attack is spotted by the large, more or less compact mass of matting on the stem. On removal of the mat the external tissues of the stem are seen to have been eaten and, in this zone a circular hole is seen. From this hole a single tunnel extends up or down the centre of the stem. There is no frass on the ground, since it is all used in constructing the camouflage. The larva is cylindrical, and the thoracic plate is smooth.

(*b*) *Zeuzera* (Cossidae) has no external matting and is an internal feeder with an irregular gallery in the sapwood usually with several holes to the exterior and blocked by frass in places. Frass pellets are pushed out and are usually visible on the ground. The larva is less regularly cylindrical and the prothoracic plate is coarsely asperate posteriorly.

(*c*) Damage somewhat similar to that of *Phassus* is caused by *Indarbela,* a much smaller insect especially common on *Casuarina* and *Cassia* spp. Here the external matting is more diffuse than in *Phassus,* with linear branches. However the treatment advised will serve for this species also, although probably less simple to apply (*vide plate* 8).

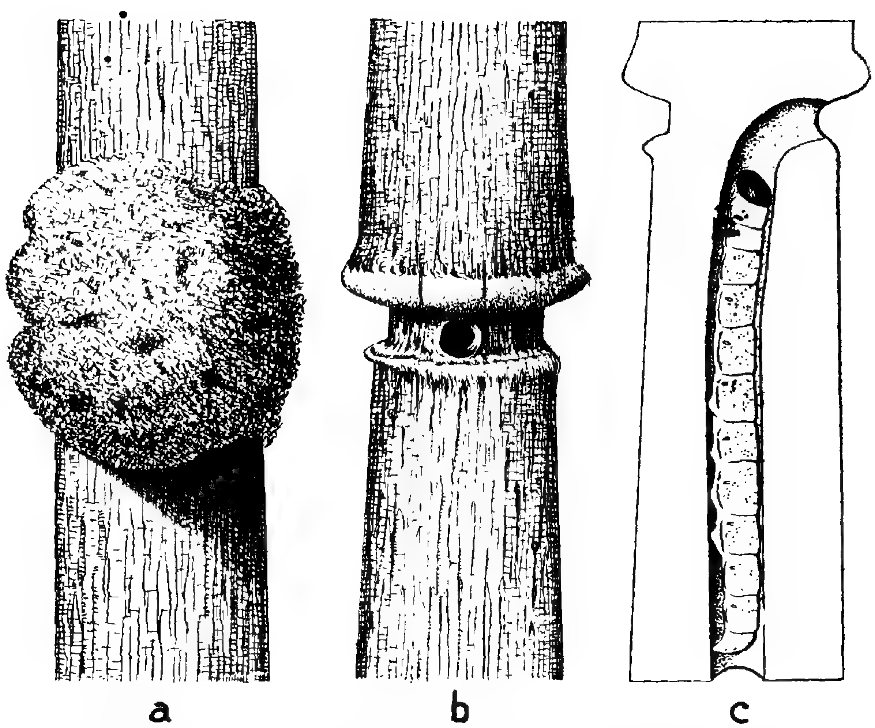
Natural checks.—A Tachinid fly, *Raphis elongata* Wulp. has been reared on one occasion from *Phassus malabaricus* brought from Coorg. Woodpecker holes are fairly common but I think, because of the mobility of the larva, the woodpecker must usually be unlucky.

Control measures.—Since the *Phassus* larva, when disturbed, retreats into its tunnel which has no other exit, we have it trapped so to speak and can deal with it by fumigation or by insertion of a contact poison. My first experiments consisted in inserting a small piece of tow soaked in carbon bisulphide into the entrance hole: this was 100 per cent. successful but has disadvantages. No doubt cyanamide, chloropicrin or other fumigants would be equally successful. Tow soaked in kerosene was usually lethal but the simplest and most efficient of the many methods tried was to insert a blob of tar on a twig (or a piece of tar-soaked tow) in the hole. The larva invariably, in my experience, pushes its head into the tar and succumbs.

Procedure*

1. **Locate sites of damage as shown by the external matting of frass and silk.**
2. **Expose entrance hole to tunnel by removing matting.**
3. **Insert a blob of tar on the end of a twig into the hole and leave it there.**

* This treatment does not work for *Zeuzera* because of its different tunnelling system but fumigation with carbon bisulphide was successful in cases where leaks in the system could be blocked with clay.



Stem attacked by *Phassus* showing in *a*, the external matting, in *b* the damage revealed after removal of matting and in *c*, a section with the larva in its tunnel.

So far as is known the life-cycle of *Phassus* is annual so it may be necessary to organize treatment only once a year. It is obviously preferable to treat early, before much damage has been done. Apparently in the Himalayas emergence occurs during July and August and in south India from April to June but further observation may show less sharply defined periods.

A test of control.—Darjeeling experiments with tar-blobs on a small scale were 100 per cent. successful but large scale operations were obviously required. Numerous forest officers who applied for advice on the subject were asked to try the method but whether they did or not is not known.

In 1936, A. L. Griffith (then Provincial Silviculturist, Madras) sent larvae of *P. malabaricus* as attacking *Cityus scoparius*, a frost hardy species of considerable importance for clothing the downs at Ootacamund; he remarked that attack appears to cause the death of the plant in each case and asked for advice on any practical control measures. I then asked Griffith if he would test the method as a practical proposition. He accordingly collaborated, and the following extracts are from his subsequent account (1938).

Experiments were carried out in three divisions, *Trema orientalis*, used as a shade plant for mahogany, being the test species. The results are shown in the statement below. In the great majority of the cases in which larvae were unaccounted for, multiple attack on the same stem had occurred and the larvae seemed to have bored new exit holes. In the cases of single larval infection on a stem the larva was invariably found dead. For important tree species the method is considered practicable and reasonably cheap. In this locality the insect is a pest only of young trees up to 20 ft. high and is never above about 8 ft. from ground level.

Locality	*Kannoth*	*Nilambur*	*Dhoni*
No. of holes treated ..	282	115	415
Larvae found in tar ..	150	86	17
Larvae found dead in tunnel after touching tar ..	87	16	249
Larvae unaccounted for	45	13	149
Percentage success ..	84	89	64
Percentage failure ..	16	11	36

Griffith's suggestion that larvae in some cases may have bored new exit holes is interesting; I have seen only one case where a gallery had two exit holes. On the other hand it is possible that a considerable proportion of the recorded failures might be explained if galleries from which adults had emerged (*i.e.*, empty tunnels) were treated. Vacated sites of attack look very much the same as active sites, for some time at least, only a gap in the camouflage being visible on close inspection.

Remarks.—*Phassus* attack seems to be limited to young trees and to be accessible from ground level, facts in favour of the treatment. I should appreciate information from any forest officer who has organized operations on these lines. It should be noted that the treatment will not stop re-infection which may come from forest near plantations. However young plantations are highly conducive to the mass production of *Phassus* and check is highly desirable.

A NOTE ON THE DEPARTMENTAL CULTIVATION, COLLECTION AND CURING OF CARDAMOMS IN THE EVERGREEN FORESTS OF MADRAS PRESIDENCY*

BY A. H. KHAN, I.F.S.

Summary: The method of propagation of wild cardamons in evergreen forests, and the technique of raising new plantations in suitable areas are described with figures of cost and yield. Hints on collection, curing and storage with a description and sketch of a cardamom drying kiln are given.

1. Habitat and Localities of Production

In Madras Presidency cardamoms occur naturally in the evergreen forests of the western Ghats preferring northern and western slopes. The plant flourishes best on rich loamy soil over an undulating ground at an elevation between 2,000 and 4,000 feet above mean sea level.

The typical areas of natural cardamoms in the forests of Madras Presidency are the evergreens of the Silent Valley in Palghat Division, Kanikatty in Tinnevelly Division and Chandanathode in Wynaad Division. In these moist evergreen areas the cardamoms tend to be gregarious where the middle storey is sparse or absent, and plenty of diffused light can enter through the top canopy. The cardamoms do not thrive well where the canopy is too open, letting in direct sunlight on the plants.

The gaps created by selection fellings in these forests bring in light conditions favourable for the growth of the plants and the gaps are readily invaded by the cardamoms, if the soil conditions are favourable and mother plants exist nearby.

2. Methods of Cultivation

(*i*) EXPANSION OF NATURAL CARDAMOMS.

Silent Valley practice.—In the Silent Valley the departmental working of cardamoms was taken up in 1933. The operation consists of (*i*) the collection of cardamoms already occurring naturally, chiefly in the gaps created by the selection fellings and (*ii*) expansion of the natural crop by planting out natural transplants in gaps which have not been invaded by cardamoms naturally. The Silent Valley technique is given below.

Advantage is taken of the natural invasion of cardamoms in the gaps created by selection fellings. The gaps bring in the light conditions suitable for the regeneration of cardamoms. In the year after felling young seedlings of cardamoms begin to make their appearance on the periphery of the gaps where the mother plants happen to be in the neighbourhood.

In the second year after felling all the gaps in the coupe are inspected. In such of the gaps as have not been invaded naturally, the cardamoms are planted artificially by transplants removed from the congested parts of the naturally invaded gaps.

The planting is done in June-July at the commencement of the south-west monsoon, in crowbar holes, on the periphery of the gaps at an espacement of 6 ft. × 6 ft. away from natural reproduction of the valuable tree species or areas filled in artificially with tree species. Incidentally planting on the periphery of the gaps helps to avoid the direct sunlight in the middle of the more open gaps. The smaller gaps unfit for the artificial regeneration of tree species are completely planted with cardamoms.

The natural cardamoms of the Silent Vallev are of the Malabar variety. The plants begin to yield a light crop in the third year, and a partial or full harvest from the fourth year onwards.

Weeding and tending.—In the Silent Valley no special weeding or tending is done after

*This note is based on writer's personal experience in the working of cardamoms in the Madras Presidency from 1933 to 1938. The figures of costs and prices given are all pre-war.

planting. In the naturally invaded gaps the regeneration is usually profuse, and in the planted gaps also a fair number get established. The established plants remain well above the undergrowth for the first three or four years. But if regular weedings during the first three years are done, it will result in a greater number of established plants with better spread of clumps. The surrounding undergrowth, though it may not be overtopping the plants, arrests the spread of the rhizome considerably, resulting in reduced yield. The writer is of the opinion that regular weedings during the first three years, keeping the plants free from undergrowth to a radius of at least 2 ft. all round and tending in subsequent years when necessary, will prolong the life of the plants and double the annual yield, if not more. It is worthwhile investigating the practicability of weeding and tending in the Silent Valley gaps in spite of the difficulty of the operation due to the scattered distribution of the plots over extensive areas.

In the Silent Valley gaps the shrubby undergrowth and species like *Macaranga* etc., begin to get the upper hand in about four or five years and the result is definite suppression of the cardamoms leading ultimately to their extinction. It is, therefore, necessary to keep back all undergrowth which threatens to overtop the cardamoms clumps.

Another point of importance is the maintenance of the vitality of the cardamom plant. The plant remains active for the first seven or eight years after which the aerial shoots begin to decay. This condition of the plants is already noticeable in six or seven years old gaps in the Silent Valley. The treatment recommended for these old clumps is to cut back the decaying shoots at the root stock. This will help new adventitious shoots to come up and stimulate the production.

It may be mentioned that in the Silent Valley the departmental collection of cardamoms was taken up with the collection of other minor forest produce, primarily as a safeguard against fire risk from contractors' men, and with this the artificial cultivation of cardamoms by planting up gaps was taken up as a side line to timber working. The system is not recommended for an area where the advantages of gaps created by timber working do not exist, that is to say special fellings for the cultivation of cardamoms in small groups is inadvisable.

The greatest disadvantage of the system is that the gaps are scattered over extensive areas and are very difficult to manage both from the point of view of maintenance and protection. Moreover the canopy conditions in the gaps cannot remain constant for long, and unless the light conditions are adjusted periodically the cardamoms are bound to disappear as the gaps close up.

(*ii*) Cultivation of cardamoms in concentrated plantations in Tinnevelly Divisions

In 1937 the possibilities of the departmental cultivation of cardamoms in the Tinnevelly evergreens were investigated. The Tinnevelly evergreens were found to be eminently suited for cardamom cultivation. Here too the gaps created by selection fellings had been invaded by natural cardamoms. But the working of the selection coupes in the area was not regular and the expansion of wild cardamoms could not be taken up progressively on the Silent Valley lines. It had to be considered whether to make small clearings in the forest where cardamoms occur naturally and wait for the natural regeneration to spread, or to raise concentrated plantations artificially on systematic lines as is done in well managed private plantations.

The writer after acquainting himself with the progress made in cardamom cultivation in the Silent Valley, and also visiting some of the well managed cardamom plantations in Madura and Travancore, reported in favour of concentrated planting on systematic lines. The points in favour of raising regular plantations as against expansion of wild cardamoms by making clearings in the forest are summarised below.

(*i*) The difference between the plantation plants (nursery raised and transplanted in pits 2 ft. × 2 ft.) and natural or "crowbar hole" plants is considerable. The luxuriance

of the latter lies only in the leafy growth and the spread of the clump is about a quarter of good plantation raised plants.

(*ii*) The enhanced yield and the supreme advantage of easy management and cheaper maintenance amply justify the increased cost of nursery and pitting.

(*iii*) The saving in costs by natural regeneration is not so real as it would at first appear. Actually it is uneconomic and more expensive. To begin with it is uncertain that natural seedlings will be coming up all over the area cleared. Granting that full stocking is achieved after artificially expanding the areas of natural seedlings by some cheap method as crowbar holes, the chief items of expense that are saved are nursery and pitting (about Rs. 24/- an acre). The clearing of undergrowth and felling for light conditions will have to be done as for regular planting and this will cost about Rs. 12/- an acre. As already said the yield from the plantation plants is about 3 to 4 times that of natural or 'crowbar hole' plants. In terms of expenditure (taking only the chief items of formation) it means that Rs. 36/- an acre (felling Rs. 12/- nursery and pitting Rs. 24/-) is spent on regular planting, whereas to get the same yield by natural regeneration it will be necessary to fell four times this area spending Rs. 48/- (at Rs. 12/- an acre) with all the uncertainty of success and difficulties of proper maintenace.

It was therefore decided to go through an experimental stage in order to gain experience before embarking upon any extensive development of cardamoms in concentrated plantations. As regards the natural cardamoms it was decided to take up the collection from the existing crop departmentally and to maintain the crop by tending systematically. The method of cultivation was studied in some of the well managed plantations in Travancore and Madura and was modified to suit forest conditions. The technique as followed for Tinnevelly is given below.

Clearing and opening of the area to adjust light conditions.—All the undergrowth in the area proposed for planting cardamoms is cleared, and such of the trees in the middle canopy which interfere with the diffused light passing through the top canopy are felled. As far as possible the trees and regeneration of more valuable species like *Mesua* and *Hopea* were favoured. A density of 0.7 to 0.8 in the top canopy is about the best for cardamom growth. At Kannikatty after the removal of the middle canopy it was found that the light conditions required for cardamoms were satisfied without felling in the top canopy, though at places groups of large trees in the top canopy did cast heavy shade, and in such cases trees were left as they were, instead of their opening at prohibitive cost. The writer has seen cardamoms doing quite well under apparently heavy shade from the top canopy. The heavy shade from the distant top canopy, does not appear to matter so much as the shade from the middle canopy. Heavy foliaged and low spreading trees are definitely harmful to cardamoms. The actual cost of opening 10 acres at Kannikatty worked out to about Rs. 9/- per acre.

Forestry and cardamom working. The felling of the trees in the evergreen forest to let in the required light for cardamom growth can always be manipulated in such a way as to leave standing the sapling and pole growth of valuable species. This judicious felling amounts to a first class tending which we cannot afford to do normally on any large scale. Such felling for cardamoms in 1938 on an area of 10 acres at Kannikatty resulted in the tending of dozens of promising *Mesua* and *Hopea* saplings which had no more danger of suppression for 20 years to come. A cardamom plantation has to be renovated after 20 years when shade conditions can again be adjusted by felling miscellaneous species and favouring the valuable species.

Clearing the debris.—At Kannikatty the debris resulting from the opening of the area was enormous. The area being out of the way, the disposal of the felled material by sale was not possible. It was therefore decided to clear the branchwood debris up to a radius of 3 ft. round the stakes only and leave the rest lying in the area. This clearing was estimated to cost Rs. 3/- an acre. In

private plantations the area is cleared of all the felled material which is utilized as fuel for the cardamom drying kiln.

Aligning, staking and pitting.—This operation is commenced about the middle of April after the area for planting has been suitably opened, and is completed by the middle of May. The staking is 11 ft. × 11 ft. At each stake a pit 2 ft. × 2 ft. × 1 ft. is dug. A cooly at -/8/- a day is said to dig 20 pits a day. There are 360 pits to an acre and the cost of pitting works out to Rs. 9/- an acre. The earth excavated from the pits is put on the lower side of the pits and left there. The pits are refilled in May with the *surrounding surface soil and not the earth dug out from the pits.* Cost of refilling is about Rs. 2/- an acre. These costs are based on figures collected from Madura and Travancore plantations.

Planting.—The planting is commenced in July at the break of the rains. In 1938 nursery raised transplants were not available for planting at Kannikatty and the planting had to be done with natural transplants only. The transplants were obtained from the congested parts of the gaps of previous years coupe leaving sufficient number in the gaps to spread naturally. The writer's recommendations were that seedlings 1 to $1\frac{1}{2}$ years old, of $1\frac{1}{2}$ ft. and above in height with a minimum of 6 culms to the rhizome should be preferred for planting in the pits. In case there was any deficiency of plants of this specification and seedlings smaller than $1\frac{1}{2}$ ft. in height had to be put in, it was recommended that two or more seedlings should be put together in a pit in order to get an initial clump of 6 or more culms.

Weeding and tending.—After planting a weeding is required in about August-September and another in December, the actual time varying with local conditions. The cost of weeding differs with the locality. Normally it should not be more than Rs. 3/- an acre for the first weeding and Rs. 2/- an acre for the second weeding. Weedings are required in the 2nd and third years also depending on the undergrowth in the area and cost Rs. 3/- to Rs. 4/- an acre.

About the middle of Febrduary of each year at the commmencement of the hot weather mulching is done by covering the bases of the clumps with fallen leaves collected in the neighbourhood of the plants. The casualties are replaced in the 2nd year in June.

In the 4th year the plants usually close up, and the tending operations 4th year onwards chiefly consist in mulching the clumps with dead leaves and cutting back occasional undergrowth. This will cost about Rs. 3/- per acre annually.

Best variety to grow.—There are two varieties of cardamoms—the Mysore and the Malabar or Travancore. The Mysore variety is more in favour and almost all the present private plantations are of Mysore cardamoms.

Nursery practice.—The following is the standard nursery practice: Nurseries are formed near streams. Fresh mature seeds taken from healthy selected plants are used for sowing. The seeds are taken out from the ripe capsules and are dried in shade after rubbing with ash. Seeds thus taken out can be used for sowing during the same season. Storing for longer periods over the season is said not to give good results. One Madras measure weighing about $2\frac{1}{2}$ lb. is said to contain 70 to 80 thousand seeds and will give about 50 thousand good seedlings.

Seed beds are 25 ft. to 30 ft. long and 3 to 4 ft. wide and about 9 inches high. Two coolies can make a seed bed of this size in a day. The soil is turned over several times and is broken into fine grain before sowing. One half to one third of a Madras measure is sufficient for a bed of 25 ft. × 4 ft.

Seed beds are usually sown from February to April. The seed is broadcast on the top of the prepared beds and covered lightly with soft earth. The beds are then covered at the top with long grass which is laid on the beds. The object is to prevent the seed from being

washed off while watering with a spray can or being eaten by birds etc. Beds are watered twice a day, morning and evening, during the first ten days, once a day for the next 10 days, and then twice a day for 20 days.

Seed germinates in about 40 days. When the cotyledons appear, a shade is erected on the beds and grass is removed with care from top of the beds. The shade is about 4 ft. high and should slant slightly to drain away rain water. Watering is done twice a day till two leaves appear in another 30 days' time, and afterwards once a week.

Transplanting in the nursery beds.—By about June or July seedlings attain a height of 6 inches when they are transplanted in other beds 9 to 12 inches apart. Transplanting is usually done after the monsoon has set in June. Transplants are watered at least twice a day if there are no rains at the time of transplanting.

Transplant beds are 9 inches high, 4 ft. wide and 25 to 75 ft. long, depending upon the convenience of the nursery site. These beds are also protected by grass shades 3½ ft. high at the lower side and 4½ ft. high at the other. The shades are constructed before the transplanting is done. These transplanting beds are formed in virgin soil and a top layer of decomposed *shola* soil* is laid on the beds just before transplanting. Only healthy vigorous plants are transplanted and small ones are left in seed beds. Transplants are allowed to grow for about a year till the following June by which time they are about 3 ft. in height and develop 4 to 8 or more new shoots. The whole clumps are taken out of the beds and planted in the pits in the plantation.

Method of raising transplants in moist clearings.—A cheaper method of raising the transplants is to transplant the seedlings from the seed beds in clearings made in moist shady localities in the forest by the side of streams. The clearing should be, however, free from heavy drip. The soil in the clearings should be well broken and worked to a depth of at least 9 inches. A top dressing of *shola* soil should also be given. The seedlings can be transplanted out when they are about 6 inches high in the seed beds in these clearings in the rainy weather in June in the same way as in the regular transplant beds. In spells of dry weather watering will be necessary. Watering well once a day will do. By this method the increased expense of forming transplant beds and a good deal in the matter of watering are saved. The clearings will have to be of course looked after carefully and kept clean of all weeds. This method requires a good deal of skill. Selection of wrong place for clearings to raise transplants may lead to disappointment. Where elephants are found, this method should be used with caution. The writer saw this method practised by a planter in Travancore with great success.

The old practice of planting sections of rhizomes from the older plants in place of the nursery raised transplants is being discarded. The clumps resulting from old rhizomes do not spread so well as the nursery raised transplants, and their productive life is dependent on the age of the rhizome transplanted.

Life of plants. The life of a plantation crop raised from the nursery transplants is 15 to 20 years if the plants do not get diseased. Well-managed plantations are, therefore, worked on 15 to 20 years' rotation, and the requisite area to ensure sustained yield is replanted annually.

Protection against insect and fungus pests.—The writer has seen in some of the Travancore plantations cases of wholesale insect defoliation and fungus attack. It is advisable that the areas planted each year should be isolated from the adjacent plantation by leaving untouched an evergreen belt of one chain wide as a guard-strip against any pest spreading from one area to the other.

Cost of formation and outturn.—The cost of formation of *one acre* of cardamom plantation is approximately as follows. The figures are arrived at after analysing data given by

* By *shola* soil is meant the surface soil containing a high percentage of decomposed vegetable matter, obtained from the evergreen or shola forests.

different planters.

	Rs.	as.	p.
First year.—Opening the area by felling trees and undergrowth and clearing debris	*12	0	0
Aligning 11 ft. × 11 ft. and digging pits 2 ft. × 2 ft. × 1 ft. ...	9	0	0
Refilling pits and planting ...	3	0	0
Cost of raising transplants in nursery	15	0	0
Weeding first year ...	5	0	0
Total ...	44	0	0
Second year.—Weeding, mulching and replacing casualties	10	0	0

The plantation begins to yield a light crop in the third year and full crop from 4th year onwards. The yield is variously stated. Good plantations in Travancore and Madura yield normally about 100 lbs. per acre (dried cardamoms) in the third year and 150 to 250 lbs. per acre from 4th year onwards. Comparing figures for different localities 60 lbs. per acre in the third year and 100 lbs. per acre from 4th year onwards is a fairly safe estimate. Basing the yield on these figures the expenditure from the third year onwards, which is chiefly collection and curing, is as given below:

Third year.—Yield 60 lbs. (dried) per acre. The cost of collection and curing of cardamoms will vary according to the situation of the plantation. The expenditure during third year as estimated for the plantation at Kanikatty is as follows:

	Rs.	as.	p.
Collection and cleaning green cardamoms for one acre yield	7	8	0
Transport of green cardamoms from Kannikatty to the drying shed at Mundanthorai 10 miles (cart track) for one acre yield	7	8	0
Cost of drying at Mundanthori for one acre yield ...	1	4	0
Packing and transport to the sale depot at Ambasamudram 10 miles (motorable road) for one acre yield	0	8	0
Weeding and mulching per acre	5	0	0
Total ...	21	12	0
		or	
	22	0	0

Financial prospects of the operation.—Taking the price of the cured cardamom at Re. 1/- per lb. (the price in 1938 was about Rs. 1-12-0 per lb.) the revenue in the third year will be Rs. 60/- an acre. From the 4th year onwards the yield per acre will be 100 lbs. and the expenditure for collection and curing, etc. will be about Rs. 35/- per acre. Thus with an outlay of Rs. 54/- an acre during the first two years and recurring expenditure of Rs. 35/- from the 4th year onwards we can expect a revenue of Rs. 100/- per acre, even if the price of cardamoms is as low as Re. 1/- per lb. Taking into consideration, the 3rd year yield, it means that by the 4th year the profits repay the cost of formation, and from the fifth year year onwards the plantation yields a profit of Rs. 60/- to 70/- per acre. Most of the figures of expenditure and revenue given above are not based on actual experience and may vary to some extent in practice. They give however some idea of the financial side of the operation.

In the above figures the cost of erection of a drying kiln and the staff has not been taken into consideration. For a 100 acre plantation, allowing Rs. 20/- per acre per annum for these two items, the planter is still left with a handsome net profit of Rs. 40/- to Rs. 50/- per acre from the 5th year onwards.

3. Methods of Collection and Curing of Cardamoms

Season of harvesting.—The natural cardamoms found in the Silent Valley are of the Malabar variety. The harvesting commences in the middle of August and lasts till the end

* This item is based on actual opening of a fully stocked, evergreen area at Kannikatty, the cost will be less in opener forests.

of October. The bulk of the crop is gathered during August and September. The natural cardamoms of the Tinnevelly evergreens are of the Mysore variety. Here there are two regular crops in the year, one in May-June and the other in September. In the artificial cardamom plantations of Madura and Travancore the harvesting is usually done from September to April, there being 5 or 6 pluckings at intervals of 30 to 40 days.

The right time to commence collection is when the seeds in the fruits begin to turn dark in colour. If the collection is deferred too long, there is danger of the over-ripe capsules splitting on drying.

Method of collection.—In regular plantations the collection of fruit is done very carefully. Only the ripe capsules are picked sytematically from the plants in a series of visits during the harvesting season.

This method is, however, too expensive for the collection of wild cardamoms in gaps which are scattered over an extensive area of difficult forest. In the Silent Valley gaps the harvesting therefore is done by pulling out the whole panicle of fruits. This practice is wasteful but cannot in the circumstances be helped. When this practice is resorted to, precautions should be taken that the collection is not done too wastefully by indiscriminate pulling out of the panicles. It should be seen that the coolies do not collect the whole lot in the very first visit but restrict their collection so far as possible to only the ripe branches. Usually the cardamom plants throw out 4 or more scapes which bear fruits in different stages of ripening. The collecting coolies should be warned beforehand that no wages will be paid to them if the percentage of unripe fruits in their collection is more than what is reasonably expected of a ripe panicle. A panicle fit for collection sхould bear at least 75 per cent. ripe fruits.

In the Silent Valley the coolies hand over the collection to the forester after removing the fruits from the rachis. As the payment for collection is made on a volume measure (see under rates of collection), the coolies will be interested in removing the fruits with as much of the main stalk as possible. The subordinate in charge of the collection should see that nothing beyond the pedicel (the direct stalk of the fruit) is included in the collection when presented by the coolies for measurement. This is important as it makes a considerable difference in yield after the stalks are removed from the capsules at the drying shed. A careful check of the collection both in the forest and at the drying shed is necessary to see that no refuse is paid for.

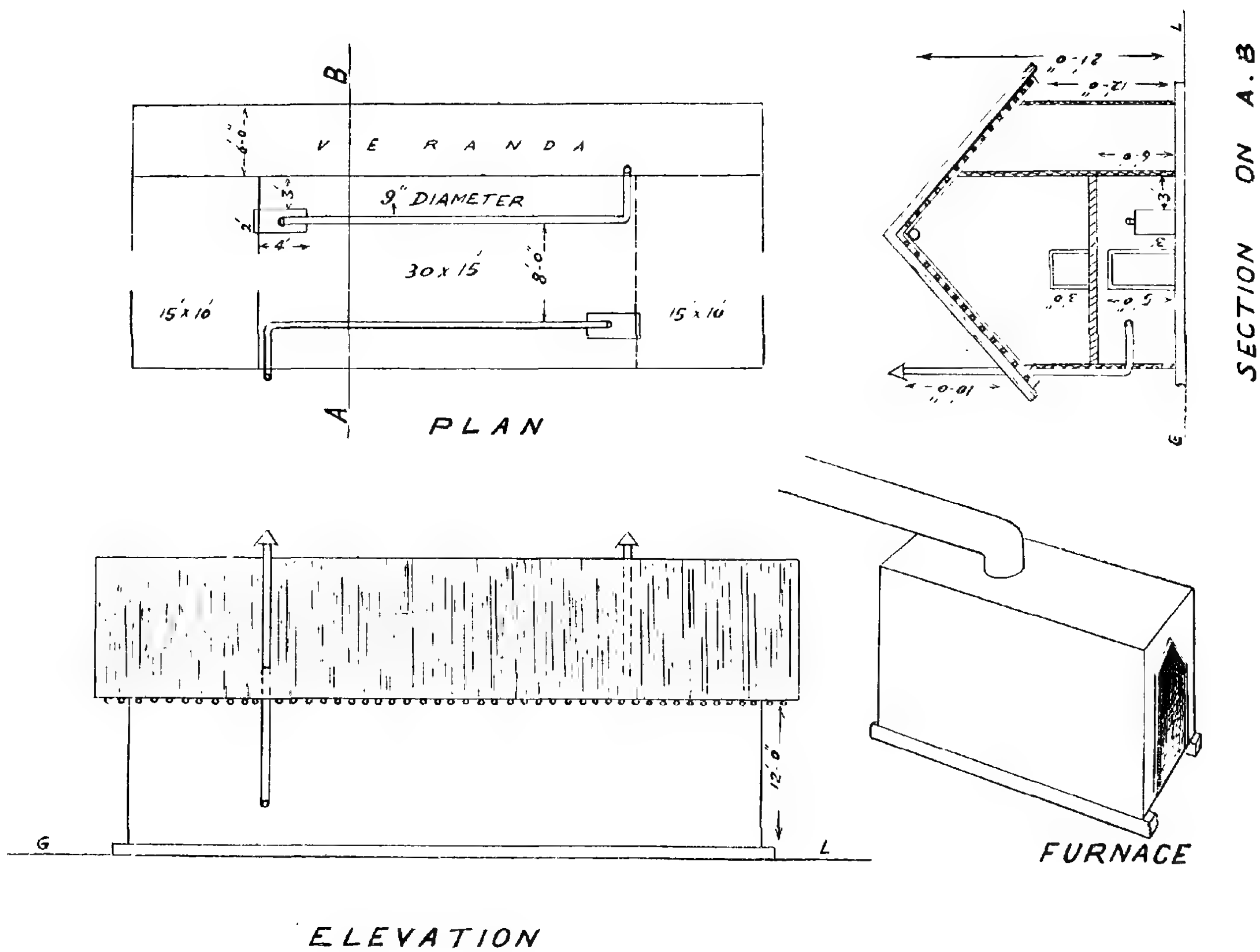
In the Silent Valley green cardamoms can stand two days rough storing in the hills and a day in transit to the drying shed without any appreciable deterioration in quality. It is, however, better to send down the cardamoms for drying immediately after collection.

Rates of collection.—The payment for the collection of green cardamoms in the Silent Valley gaps is made on a volume measure called *para* locally, weighing about 25 lbs. of rough green cardamoms. The rate paid there is 5 to 6 annas a *para* for delivery in the forest depot. The cardamom collection in the hills in leech-infested areas is hard work and will attract labour only if the coolies can earn 8 annas a day or more. A standard rate to suit local conditions can be arrived at by a sample collection on daily labour under supervision.

Cleaning of the green cardamoms before drying.—In the Silent Valley the green cardamoms after collection in the hills are transported down to the drying shed which is located in the plains at Mannarghat at a distance of 10 miles. On receipt of the roughly-picked cardamoms at the drying shed, an intensive cleaning of the green cardamoms is done by nipping off the stalks from individual capsules by hand. At Mannarghat this operation is done by women, girls and boys very cheaply at about 1 pie per lb. of finally cleaned green cardamoms.

Drying shed.—In the cardamom estates there are permanent drying kilns costing Rs. 2,000/- to Rs. 5,000/- depending upon the outturn. When the cardamom collection was

SKETCH OF THE CARDAMOM DRYING SHED AT MANNARGHAT



taken up in the Silent Valley by the department in 1933, the writer rigged up on the same principle a temporary drying shed at Mannarghat, at a cost of Rs. 288/-. The shed gave very satisfactory results, and with annual repairs remained in use up to 1938 when a permanent shed was built on the same lines.

The temporary shed built originally was a thatched building with bamboo *thatti* wallings 12 ft. high made 'air-tight' by mud plastering, only the portions of the walls abutting on the furnaces being of zinc sheets. A ceiling of bamboo mats without mud plaster to allow the vapour to escape was provided. The shed consisted of a drying room, two small side rooms for feeding the furnaces and a verandah for the coolies engaged on cleaning the cardamoms. The drying room was 30 ft. × 15 ft. divided into two chambers, one above the other, by a strong lattice work partition at 6 ft. from the floor. Two iron furnaces 4 ft. × 2 ft. × 3 ft. each were built diagonally opposite in the corners of the drying room 3 ft. away from side walls. From each of the furnaces a smoke-tight zinc pipe 9 inches in diameter was carried throughout the length of the drying room, thence through the side walls and then vertically as an outside flue. Thus in the lower chamber there were two parallel heater zinc pipes 8 ft. apart running throughout the length of the room. A sketch of the shed is given in *Plate 9*.

Method of drying.—The green cardamoms after the removal of the stalks are spread evenly on the floor of the drying room and on mats on the middle partition, the capsules touching each other. About 1,250 lbs. of green cardamoms can thus be spread at a time in a drying room 30 ft. × 15 ft. The furnaces are fed with thick green fuel and the doors of the shed are closed. Care is taken that there is no leak in the pipes as the smoke spoils the colour. It takes about 30 hours for the green cardamoms to dry completely if the furnaces are fed constantly. The cardamoms in the upper chamber dry 4 to 6 hours earlier than the lower one. The cardamoms near the furnaces on the floor and directly above them on the lattice partition dry quicker. It is essential that the cardamoms are removed from the shed as soon as the drying is complete as they lose colour if allowed to remain afterwards in the heat. About 2 cart-loads of green fuel are required to dry one consignment of 1,250 lbs. of green cardamoms yielding about 135 lbs. of dried cardamoms.

The experience in the Silent Valley is that if the cardamoms are transported down to the drying shed at Mannarghat within two days of their collection in the hills, have their stalks picked off the capsules at Mannarghat immediately after arrival and are put in the drying shed the same day, provided the precautions in the drying shed, as stated above, are taken, the best quality of dried cardamoms, green in colour and smooth to the touch, are produced. It should be remembered that it is chiefly the colour that commands the market. The whole secret of getting the right colour is to put the green cardamoms in the drying shed as quickly as possible after collection in the forest. It is important to ensure that the collection in the hills is regulated according to the capacity of the drying shed.

Sun drying is cheaper and is practised by petty cultivators. But the price obtained for this quality is considerably lower than the good kiln dried quality, and the extra money spent on kiln drying is well covered by better prices.

Cleaning and storing.—As soon as the cardamoms are dried they are removed to the store room where they are first rubbed on a wide-meshed sieve and then winnowed to separate the grainless shrivelled fruits and other rubbish. The finished cardamoms are then immediately packed in good double gunnies and stored in a dark room after weighment. The cardamoms should on no account be left heaped up in the store room, as in wet weather they soon swell up absorbing moisture and get mildewed if packed in bags in this condition. It is necessary to store the cardamoms in a dark room as light spoils the colour.

Losses in various stages.—Loss occurs in two stages, firstly when the stalks are removed from the capsules, and secondly on drying. The loss after the removal of the stalks from the capsules should be about 25 to 30 per cent. Higher deficit indicates that the collection is not being done properly in the hills. The weight on drying in case of the Silent Valley cardamoms (Malabar variety) is reduced from 25 lbs. green to $2\frac{3}{4}$ lbs. dried. The loss on drying in case of the Mysore variety will be less as the Malabar cardamoms are more juicy and will further vary with the locality of production. It is, therefore, worthwhile to determine the standard loss to be expected for a new locality by careful records at the very first consignment as this will afford a good check for further control in the depot.

THINNING IN DEODAR REGENERATION

By H. S. Jamwal, M.F.

(Conservator of Forests, Jammu.)

The Jammu and Kashmir forest department is indeed proud of its service that has developed a very thorough technique of artificial deodar regeneration in state forests. Any one who has ever visited the forests of Langet and Kamraj divisions in Kashmir and Ramban, Bhadarwah and Udhampur divisions in Jammu, will surely agree that the subordinate staff from forest rangers down to forest guards are so thoroughly conversant with the technique of artificial deodar regeneration that they cannot only regenerate most obstinate areas under the uniform system of fellings when and where they are called upon to do it, but are often not afraid of even creating gaps which sometimes have to be made in the interest of existing crop, for reasons other than silvicultural ones.

From the great progress made during the last ten years in artificial regeneration obtained by various methods such as broadcast sowing the areas after burning the slash *in situ*; sowing ash beds; sowings made in lines or even transplantings done from nursery stock, it is obvious that the deodar seedlings which spring up in burnt areas or in ash beds are invariably so dense that serious congestion sets in and the growth of seedlings is greatly retarded in many places.

Divisional forest officers in charge of divisions, even if they are interested, have hardly time in these days of war supply to go through the thinning operations required to be done in these thickets and subordinates for want of knowledge and guidance hardly dare to touch them and release the young seedlings from suppression and root competition.

No doubt, in Kulu Sir G. Trevor developed the method of thinning by using a 4 ft. stick in young pole crops, but the writer believes that there is hardly anything at present available to guide the lower service to do thinning (or call it cleaning, if you like) in thickets of young deodar seedlings which range from 1 ft. to 8 ft. height and in which congestion often remains unnoticed and unattended with the result that young seedlings lose the advantages of artificial tending.

Two years ago the writer took up the work of thinnings in such deodar thickets from 1 ft. to 8 ft. in height as described above and deputed Mr. Habib Khan, A.C.F., Ramban division, to carry out measurements etc. in compartment No. I. Danamdhar of Udil Range. Mr. Khan was shown on the spot the methods of carrying out the operations and after some time he collected the following data. He took ten readings for each average height as given below:

Average height.			*Average distance required from seedling to seedling.*
ft. in.			ft. in.
1—5	..	..	0—9
1—9	..	..	0—10
2—5	..	..	1—0
2—11½	..	..	1—2
3—5	..	..	1—4
4—0	..	..	1—8
5—2	..	..	1—9
5—11	..	..	1—10
7—3	..	..	2—3
*8—2	..	..	2—3

The above spacing is approximately applicable to a definite range of heights of seedlings and consequently easily intelligible results derived from those above are as follows:

Distance, i.e. Spacing.			*Range of height of seedlings to which this spacing is applicable.*
(Inches)			*(Feet and inches)*
9	..	..	1—6 to 2—0
12	..	..	2—6 to 3—0
18	..	..	3—6 to 4—0
21	..	..	5—0 to 6—0
27	..	..	7—0 to 8—0

This spacing between seedlings in thickets of the above heights is by no means claimed as absolutely correct or final; but, if followed, there will be little difficulty for the subordinate staff to do clearings in seedlings groups and there will also be little chance of making mistakes in such operations. In other words, the above spacing can safely be adhered to in young deodar seedlings in the same way as the 4 ft. stick is being used in pole crops. It is, however, essential that the operations should be repeated every third year till the smallest seedlings (*i.e.* those 1 ft.-2 ft. in height) attain the so-called maximum height of 8 ft. after which it may reach the sapling or pole stage and be brought under 4 ft. stick method.

The deodar forests of Kashmir having been worked under the uniform system for the last 20 years or so, contain large areas of dense crops of young seedlings obtained artificially and needing immediate attention. It is therefore urgent that some such data is worked out and made available for the subordinate staff to enable them immediately to release the young seedlings from congestion and its deleterious effects.

It is hoped that even an illiterate forest guard or forester can carry out the above simple operations in his beat without difficulty or even without fear of committing serious mistakes and the sooner they do it the better it will be for the prosperity of the deodar forests.

* 8 feet may be regarded a stage beyond which regeneration is considered as established, though it is a bit higher than ordinarily taken.

EXTRACTS

MANURES AND MANURING

BY SUDHIR CHOWDHURY

CHAPTER III*

Farm Manures.

The term 'Farm Manure' covers properly the dung and urine of all the domestic animals kept on the farm including the customary litter. It is the oldest and is still undoubtedly the most popular of all manures. Being originally formed from vegetable substance it contains all the elements present in the plant itself. It affords a means whereby the unused portion of the crop, the residue of the finished farm product, may again be returned to the soil.

Ingredients of Farm Manures :

The manure derived from each of the larger domestic animals in most cases is composed essentially of three different ingredients: dung, urine, and litter. The nature of each of these classes of material must be briefly considered.

1. *Dung*.—The dung in a fresh state contains from 70 to 80 per cent. water and is composed of the insoluble and undigested residue of the food with certain materials derived from the digestive juices of the intestinal canal and to a certain extent admixed with waste tissues of the alimentary canal. It is an exceedingly complex mixture, the chief substances present in it being woody fibre, undigested cellulose, fat and starch, mucus, and bile pigments, together with certain decomposition products such as indole and skatole produced by putrefactive bacteria as well as fatty acids, alkaline soaps, and small amounts of magnesium and calcium phosphates. It varies considerably in composition; in a general way, the dung usually contains about one-third of the total nitrogen of the faeces, one-fifth of the total potash, and nearly all of the phosphoric acid. The constituents of the fresh dung are not soluble to any great extent and not in a condition to serve immediately as the food of plants. Before its elements become to any great extent available, the dung must undergo decomposition.

2. *Urine*.—The urine is a watery solution of chemical compounds derived from the digested food and from waste products arising in muscular and other tissues. It contains about 96 per cent. of water and 4 per cent. of dissolved materials. The most important substance present in it is urea, a nitrogenous crystalline compound originating from proteins absorbed by the blood, and in part, apparently from leucine and tyrosine produced by tryptic digestion in the intestines. Urea is also a product of the disintegration or wear and tear going on in various organs. It amounts to about one half of the total solids of the urine. Other nitrogenous waste materials are uric and hippuric acids; these are met with chiefly as sodium salts, sodium and potassium, hippurate being especially characteristic, of the urine of herbivorous animals. About one per cent. of sodium chloride is found in urine also and small amounts of acid sodium phosphate, phosphates of calcium and magnesium, and the sulphates of sodium and potassium.

3. *Litter*.—The character and value of manure is very largely affected by the kind and amount of litter used. Litter, while used primarily to afford a comfortable bed and to assist in keeping the animals clean, serves to absorb and retain urine, to absorb gases to some extent, and to dilute the manure, making even distribution easier. The litter may also carry to the manure very considerable amounts of plant food and it will improve the manure in its mechanical condition. The constituents of most kinds of litter are in relatively unavailable forms and the material

*Chapter II appeared in the February 1944 issue of the *Indian Forester*.

must decompose before its food elements are brought within the reach of the plants.

Various kinds of litter are employed in the different parts of the world. Among those more commonly available are straw from the different cereal grains, hay, leaves, corn-stover, saw-dust, and planer shavings and peat moss. Earth of different kinds though strictly speaking not litter, is frequently used beneath the animals.

Straw.—The straw of the different grains is the most universally used for this purpose and is one of the most satisfactory materials that can be used for bedding. Besides being one of the by-products of the farm it is admirably suited to be used as litter, on account of its great capacity to absorb urine and considerable manurial value. The straw of the different grains differs materially in their toughness and wearing qualities but the effect of the different kinds on manure is not materially different. A ton of straw will usually contain about 16 lbs. of nitrogen, 4 lbs. of phosphoric acid, 26 lbs. of potash and 9 lbs. of lime. An average ton of farm manure contains about 10 lbs. each of nitrogen and potash. A ton of straw, therefore, contains more of these elements than a ton of average farm manure. It follows then by liberal use of straw the proportion of nitrogen and potash in manure by weight will be increased.

Leaves.—Dried leaves have good absorbtive properties but possess a lower manurial value than straw. A ton of autumn leaves of the best quality contains 6 lbs. of potash, less than 3 lbs. of phosphoric acid, and 10 to 15 lbs. of nitrogen. Autumn leaves, however, contain a very small percentage of fertilizing matter. This is due to the fact that most of their potash, phosphoric acid and nitrogen pass into the body of the trees at the approach of winter. Leaves, besides being poor in manurial ingredients, make a bad litter, as they ferment but slowly. In this fermentation a large quantity of cold sour humic acid is formed which seriously impairs the value of the manure.

Corn-stover.—Although corn-stover has such value for food that its use for litter is inexpedient from an economical point of view, it is nevertheless not infrequently used for litter. If well dried, it has good absorptive qualities but unless shredded or cut it is too coarse to be satisfactory. Its manurial value when well dried is about the same as that of straw.

Sawdust and Planer Shavings.—These materials have relatively little manurial value. If thoroughly dried, however, they are good absorbents and contain about 1 per cent. nitrogen, 0.1 per cent. potash, and 0.5 per cent. phosphorus pentoxide. Neither sawdust nor shavings will add materially to the plant food content of manure but when they are used as litter in moderate amounts they render the manure very open and porous and therefore favour rapid oxidation and fermentation. The turpentine found in pitch-pine sawdust may seriously retard its decomposition in the soil.

Dried Bracken.—It is often used as litter in mountainous and thickly wooded districts. It is not so absorbent as other litters, but is of value on account of its composition. This varies with the age at which it is cut and with other circumstances. A dried sample examined by Homberger contained 0.706 per cent. nitrogen, 0.13 per cent. potash, and 0.12 per cent. phosphorus pentoxide, while two samples examined by Hughes contained in one case (young plants) 2.42 per cent. nitrogen, 1.15 per cent. potash, and 0.6 per cent. phosphorus pentoxide, while in the other (old plants) there were only 0.9 per cent. nitrogen, 0.1 per cent. potash and 0.3 per cent. phosphorus pentoxide.

Peat Moss.—Peat moss is largely used as litter in Germany, and to some extent in England and America. It possesses great porosity and absorptive power for liquids, being capable of taking up about 10 times its own weight of water, while straw takes up only about 3 times its weight and in itself often contains a considerable quantity of nitrogenous matter, varying in different

samples from 0.3 to as high as 2.0 per cent. It also has strong absorptive power for gases, *e.g.*, ammonia, and acts as an antiseptic in preventing the too rapid putrefaction of the organic matter of the excreta and the injury to the health of the animals resulting from such putrefaction. The manure is richer, especially in nitrogen, than that produced by straw. The chief drawback to peat as a manure is the difficulty with which it undergoes decay or putrefaction.

The chief manurial constituents according to American analyses are: water 61.5 per cent., nitrogen 0.85 per cent., potash 0.18 per cent., phosphorus pentoxide 00.8 per cent.

Tanners' Refuse.—This is sometimes used as a litter, but is of comparatively little value. Storer gives its average composition—nitrogen 0.16 per cent., potash 0.08 per cent., phosphorus pentoxide 0.04 per cent.

Earth.—Generally speaking any substance which has great absorptive as well as retentive powers for nitrogen and the soluble fertilizing matters present in the manure and whose price is nominal, is well suited for acting as litter. Ordinarily loam soil possesses the above qualifications and is a substance to be had for nothing. A great objection is that it forms a dirty litter. Moreover it possesses a very small percentage of fertilizing element. Sandy earth especially if coarse, is a relatively poor absorbent. Fine earth, if first well dried, especially if it contains considerable organic matter, is a fairly good absorbent. The use of such earth beneath or behind the animals in barns or stables is calculated to favour the production of manure of good quality. Such earth is superior to strawy litter according to some of the most recent investigations, since it contains much less highly carbonaceous organic matter. It has been found that the presence of excessive amounts of such matter in manure, as for example, when straw is abundantly used for bedding, produces conditions favourable to a considerable loss of nitrogen in the form of uncombined nitrogen gas.

Composition and Character of Farm Manures:

"Although the probable composition of farm manures is so difficult to state in exact figures, compilations of the available data have yielded percentages which, while they demand a most liberal interpretation, afford considerable light regarding the differences that normally exist between the excrement of various animals. Of these compilations, Van Slyke's is perhaps the best.

THE COMPOSITION OF FRESH MANURE

Excrement		Percentage of			
		H_2O	N	P_2O_5	K_2O
Horse:	Solid 80 per cent.	75	0.55	0.30	0.40
	Liquid 20 per cent.	90	1.35	trace	1.25
	Whole Manure	78	0.70	0.25	0.55
Cow:	Solid 70 per cent.	85	0.40	0.20	0.10
	Liquid 30 per cent.	92	1.0	trace	1.35
	Whole Manure	86	0.60	0.15	0.45
Sheep:	Solid 67 per cent.	60	0.75	0.50	0.45
	Liquid 33 per cent.	85	1.35	0.05	2.10
	Whole Manure	68	095	0.35	1.00
Swine:	Solid 60 per cent.	80	0.55	0.50	0.40
	Liquid 40 per cent.	97	0.40	0.10	0.45
	Whole Manure	87	0.50	0.35	0.40

"Since the horse does not ruminate its food, the manure is likely to be of an open character. It is also a fairly dry manure, as is that from sheep, the liquid in these two manures making up 20 and 33 per cent. respectively of the whole product. The complete manure from these two animals contains 78 and 68 per cent. respectively, of water—a considerable contrast to the 86 and 87 per cent. presented by the cattle and swine excrements. Cattle and swine manures being very wet are rather solid and compact. The air, therefore, is likely to be excluded to a large degree and decomposition is relatively slow. They are usually spoken of as cold, inert manures as compared with the dry, open, rapidly heating excrements obtained from the horse and the sheep.

"In every case except that of swine the liquid portion of the various excrements is much the richer in nitrogen, containing on the average more than twice as much when compared on the percentage basis. The liquid is also richer in potash than the solid, average for the four classes of animals 1.36 per cent. as compared to 0.34 per cent. contained in the solid manure. Most of the phosphoric acid, however, is contained in the solid excrement, only traces being found in the urine except in the case of the swine. It is therefore evident that the liquid manure, pound for pound is more valuable in so far as the plant food elements are concerned. The advantage leans heavily toward the urine also in that the constituents therein contained are immediately available; this cannot be said of the solid manure."

Variable Composition of Manures :—

The manure produced on an average farm is rather likely to vary markedly in composition and character from time to time. It may even change radically from one day to another. There are six general factors that are usually listed as being responsible for this variation:

(1) *Litter.*—Perhaps under ordinary circumstances the amount and character of the litter has as much to do with the variation in manurial composition as has any other one factor, if not more. That bedding must exert a marked effect on chemical composition is evident from the following analyses:

Composition of Litter

	Nitrogen.	Phosphoric Acid.	Potash.
Wheat straw ..	0.48	0.25	0.9
Barley straw ..	0.57	0.26	1.2
Oat straw ..	0.72	0.19	1.2
Rye straw ..	0.57	0.28	1.4
Peat ..	2.63	0.20	0.17
Leaves ..	0.65	0.15	0.30
Sawdust and Shavings ..	0.10	0.20	0.40

Sawdust and shavings add little of value to the manure and really act as a diluent. While they are good absorbents they decompose so slowly as to make them somewhat objectionable on light soils. Leaves decompose readily, but add little fertility. Cereal straw carries no more nitrogen than does average manure, and this nitrogen, like that of peat or muck, is not readily available as plant food.

(2) *Class of Animal.*—The second factor causing radical variation in the composition of farm manure is the class of animal by which it is produced. The following analyses by Stoeckhardt illustrate this point clearly:

PERCENTAGE COMPOSITION OF ANIMAL EXCREMENTS.

	Solid Excrement				Liquid Excrement			
	Sheep	Pigs	Horses	Cows	Sheep	Pigs	Horses.	Cows.
Water ..	58	80	76	84	86.5	97.5	89.0	92.0
Solid matter ..	42	20	24	16	13.5	2.5	11.0	8 0
Ash ..	6	3	3	2.4	3.6	1.0	3.0	2 0
Organic matter ..	36	17	21	13.6	9.9	1.5	8.0	6.0
Nitrogen ..	0.75	0.6	0.5	0.3	1.4	0.3	1.2	0.8
Phosphorus pentoxide ..	0.6	0.45	0.35	0.25	0.05	0.12	..	..
Alkalies ..	0.3	0.5	0.3	0.1	2.0	0.2	1.5	1.4
Lime and Magnesia ..	1.5	0.3	0.3	0.4	0.6	0.05	0.8	0.15
Sulphur trioxide ..	0.15	0.05	0.05	0.05	0.4	0.05	0.15	0.15
Common salt ..	0.025	0.05	trace	0.005	0.25	0.5	0.2	0.1
Silica ..	3.2	1.6	2.0	1.6	trace	trace	0.025	0.01

(3) *Individuality, Condition and Age of Animal.*—Various animals differ in capacity, some retaining much more of the elements contained in the food than do others, and consequently producing a poorer manure.

If the animal is low in flesh, or in so-called poor condition, it must take from its food the materials necessary to bring the body into a better or well nourished condition. This change will make necessary the removal from the food of large quantities of protein and will to just the extent to which this is taken, reduce the value of the manure.

So long as the animal is making growth, that is, forming new bone and muscle, the elements which enter into this new bone and muscle must be taken out of the food, and the excreta, therefore, poorer than those of animals similarly fed which have completed their growth. The elements chiefly affected are nitrogen and phosphoric acid, both of which enter largely into the bones, and the nitrogen also into the muscle. The quality of manure made from well-fed mature animals is likely, therefore, to be considerably better than that made from young animals.

(4) *Food of Animal.*— Other things being equal, the richer the food of the animal in plant food constituents, most important among which are nitrogen, phosphoric acid, potash and lime, the more valuable are the excreta for manure. The manure from animals fed largely on straw, cornstover or timothy hay, will be comparatively poor, especially in the valuable element nitrogen, because these foods are poor in nitrogen: while the excreta from animals receiving a liberal quantity of such foods as wheat bran, gluten meal and cotton seed meal will be rich, particularly in nitrogen and phosphoric acid. Wheeler in studying the rations of chickens found the following difference in the manure produced:

	Percentage of			
	H_2O	N	P	K
Fresh hen manure (Nitrogenous ration) ..	59.7	0.80	0.41	0.27
Fresh hen manure (Carbonaceous ration) ..	55.3	0.66	0.32	0.21

From Ohio, where the production of manure has been most thoroughly investigated, the following data may be quoted:

Ration	Percentage of		
	N	P	K
Corn and mixed hay ..	1.49	1.23	1.11
Corn, oil meal and hay ..	1.55	1.24	1.02
Corn, oil meal and clover..	1.68	1.26	1.04

(5) *Product derived from Animal.*—Such essential elements of plant food as are contained in any products for which animals are fed, such as milk or wool, must, of course, come in the last analyses from the food, and accordingly there remains so much the less of these elements to be voided in the excreta. Milk contains considerable nitrogen and phosphoric acid and a moderate amount of potash. Wool fibre contains a large amount of nitrogen, while in the oil or yolk of eggs a large amount of potash is found. The manure from milch cows is likely to be relatively poor in nitrogen and phosphoric acid.

(6) *Handling Manure.*—"In dealing with a product of which almost one half is liquid, there is great danger that a considerable amount of valuable plant food will be lost by leaching. The modification and consequent lowering of the plant food value of farm manure is a vital question in the economic handling of this product. Next to the litter, lack of care is perhaps the most important single factor concerned in altering the chemical composition of manures in general. The influence of handling is so clearly brought out by the following figures from Schutt, on mixed horse and cow manure, that further discussion seems unnecessary. The protected manure in this case was in a bin under a shed. The exposed sample was in a similar bin but un-protected from the weather."

	Loss at the end of 6 months (Percentage)		*Loss at the end of 12 months (Percentage)*	
	Protected	Exposed	Protected	Exposed
Loss of organic matter ..	58	65	60	69
Loss of nitrogen ..	19	30	23	40
Loss of phosphoric acid ..	0	12	4	16
Loss of potash ..	3	29	3	36

Amount of Manure Produced by Different Farm Animals :

"A well-fed, moderately worked horse will produce daily from 45 to 55 pounds of manure, of which from 10 to 11 pounds is urine. A cow, on the other hand, having a greater food capacity, will excrete from 70 to 90 pounds during the same period, of which from 20 to 30 pounds is liquid. Swine and sheep, varying so greatly in weight, will excrete such widely different quantities that it is difficult and misleading to express the amount based on the individual. A clearer method of comparison is that employed below, in which a thousand pounds in weight of animal is made the basis of the calculation:"

MANURE EXCRETED BY VARIOUS FARM ANIMALS TO THE 1,000 POUNDS LIVE WEIGHT

Animal		Pounds a Day	Tons a Year
Horse	..	50	9.1
Cow	..	70	12.7
Steer	..	40	7.3
Swine	..	85	15.5
Sheep	..	34	6.2

"It is quite evident that, for the weight of animal, the swine and the cow give the heaviest production of manure on the farm, but it should be remembered also that they consume the greatest amount of food. Whether these animals are the most economical in production of manure must depend largely on age and individuality."

Heiden's Formulas :

"Perhaps a better and more nearly accurate means of calculating the probable production of manure is from the food consumed, rather than from the combined weight of animals kept. Formulas have been devised from experimental data in Germany and are designated as Heiden's formulas. From the amount of absolute dry matter fed and the excrement produced Heiden was able to determine certain definite relationships of the latter to the former. These, of course, varied for different animals, being 2.10 for the horse, 3.80 for the cow, and 1.80 for sheep. For example, if a horse received 20 lbs. of dry matter daily, the manurial production would be 42 pounds."

Cattle Manure :

The composition of cattle manure is very much less constant than the horse manure. It contains considerably more water than the manure of either horses or sheep. Its average plant food content is lower than well kept manure from either of these animals. Cattle manure being relatively wet and poor in soluble nitrogen compounds ferments and heats slowly.

In composition the cattle manure varies very widely. The results of 79 analyses made in the Experiment Station at Amherst, Massachusetts, showed a range as follows: for nitrogen 1.36 to 0.21 per cent., for phosphoric acid 0.75 to 0.10 per cent.; for potash 1.40 to 0.13 per cent. Snyder reports the range for the same elements to be for nitrogen 0.8 to 0.4 per cent.: for phosphoric acid 0.9 to 0.3 per cent; for potash 0.9 to 0.3 per cent. According to Voelcker, the composition of Indian cattle dung and urine is as follows:

Composition of Indian Cattle Dung and Urine

	Dung from			Urine from	
	Lean Cattle	Grainfed, cart bullocks (air dried)		Lean cattle	Grainfed, cart bullocks.
Moisture ..	19.59	17.86	Water & Volatile matters	91.77	90.62
*Organic matter ..	59.26	61.89	Non-volatile organic matters ..	5.29	7.64
*Mineral matter (ash) ..	21.15	20.25	*Mineral matter (ash) ..	2.94	1.74
	100.00	100.00		100.00	100.00
*Containing Nitrogen ..	1.34	1.08	Total Nitrogen ..	0.956	1.168
Equal to ammonia ..	1.62	1.31	Equal to ammonia ..	1.161	1.418
*Containing Insoluble Siliceous matter	14.43	16.75	*Containing Silica ..	0.004	0.010
Oxide of iron and alumina	3.36	1.36	Lime ..	0.161	0.080
Lime ..	1.04	0.85	Magnesia ..	0.249	0.570
Magnesia ..	0.44	0.30	Potash ..	0.528	0.613
Potash ..	1.16	0.60	Soda ..	0.050	0.029
Soda ..	0.34	0.26	Phosphoric acid ..	0.022	0.022
Phosphoric acid ..	0.47	0.54			
Equal to tribasic Phosphate of lime ..	1.03	1.18			

The quantity of manure voided by cattle is much greater than that produced by the horse, which compensates in a measure for the more dilute character of the liquid portion. An average cow, if properly fed, will excrete approximately 65 pounds of manure per day, about 25 per cent. of which is represented by the liquid portion. A ton of manure would contain ten pounds each of nitrogen and potash, and six and two third pounds of phosphoric acid. •

Horse Manure :

The manure from horses is generally more valuable than that from the other larger domestic animals excepting sheep, provided it has been well kept. It is richer in nitrogen and usually also in phosphoric acid and potash than the manure of either cattle or hogs. It contains relatively little water and ferments rapidly. During fermentation it usually attains a high temperature and unless kept very compact and moist, it is likely to become 'fire-fanged.' The quality of quick fermentation and heating makes it the most valuable manure for hot-beds as well as for cold wet soils and for use in truck-farming, where early maturing crops are an especial object.

The composition of horse manure is perhaps the most uniform of all the manures produced by the different farm animals. Experiments at the Cornell Experiment Station showed horse manure to have the following composition: water 48.69 per cent.; nitrogen 0.49 per cent.; phosphoric acid 0.26 per cent.; potash 0.48 per cent. Van Slyke, however, gives the following analyses:

COMPOSITION OF HORSE MANURE

	Solid.	Liquid.	Whole Manure.
	80%	20%	
Water ..	75	90	78
Nitrogen ..	0.55	1.35	0.70
Phosphoric Acid (P_2O_5) ..	0.30	trace	0.25
Potash (K_2O) ..	0.40	1.25	0.55

The total excrements voided by a horse in a day have been calculated according to the average of the experiments of Boussingault and Hofneister at 28.11 pounds, of which only 6.37 pounds consisted of dry matter. It has been estimated that every 100 lbs. of dry matter in the feed of a horse will produce about 210 pounds of manure containing about 77.5 per cent. of moisture. Allowing in addition 6.5 lbs. of bedding per day per horse and allowing also for the manure voided outside the stable, there would be available for use about $5\frac{1}{4}$ to $6\frac{1}{3}$ tons of manure per horse per annum. This amount of manure will give 69 to 73 pounds of nitrogen and from 420 to 460 pounds of mineral matter.

Sheep Manure :

The dung and the urine of the sheep are weight for weight the most valuable of the common farm animals. The total weight of the excrement voided by a sheep in a day may be taken on an average at 3.78 pounds of which 0.97 pound is dry matter. The amount of urine voided by sheep is relatively small and the elements of value in sheep manure ordinarily suffer less loss than is common in the case of other kinds of farm manure. When sheep manure is finally removed from the pens and put into loose piles in order that it may be worked into suitable mechanical condition to spread, it very rapidly undergoes decomposition and heats quickly. It is then likely to lose a part of its nitrogen in the form of ammonia. To prevent this it is well to scatter some sort of chemical absorbent *e.g.*, kainit and landplaster, as the pile is built up.

Sheep manure is especially prized by many florists for use in green houses, due, doubtless in pars to its improvement of the physical character of the soil; it is also much sought for application to lawns and for the production of certain garden crops. Owing to its low water content, sheep manure is liable to ferment easily and to lose some of its nitrogen as ammonia. According to Van Slyke, the

composition of sheep manure is as follows:

COMPOSITION OF SHEEP MANURE

——	Solid	Liquid	Whole Manure
	76%	33%	
Water ..	60	85	68
Nitrogen ..	0.75	1.35	0.95
Phosphoric acid (P_2O_5) ..	0.50	0.05	0.35
Potash (K_2O) ..	0.45	2.10	1.00

Pig Manure :

The manure obtained from pig undoubtedly varies more widely than that from the other domestic animals, because of the wider variations in the nature of their food and the conditions under which they are kept. When the food of the pig is rich, then the manure may be quite equal in quality to the other farm manures. According to Boussingault the total amount of excrements, on an average, voided by a pig in 24 hours is about 8.32 pounds of which 1.5 pounds is dry matter. The amounts of nitrogen these excrements contain is only 0.05 pound and of mineral ingredients 0.313 pound. If we take the amount of straw most suitable for absorbing this quantity of excreta from 4 to 8 pounds, then we shall find that the manure produced by a pig will contain from 0.06 to 0.071 pound of nitrogen and 0.515 to 0.772 pound mineral matter. These quantities calculated for a year give from 22 to 27 pounds of nitrogen and from 1 cwt. 87 lbs. to 2 cwt. 57 lbs., of dry matter.

Pig manure, if kept by itself, is relatively watery and usually poor in nitrogen and rich in phosphoric acid. It decomposes slowly and must be ranked as a cold manure. Van Slyke gives the following analyses of its composition:

COMPOSITION OF PIG MANURE

——	Solid	Liquid	Whole Manure
	60%	40%	
Water ..	80	97	87
Nitrogen ..	0.55	0.40	0.50
Phosphoric Acid (P_2O_5) ..	0.50	0.10	0.35
Potash (K_2O) ..	0.40	0.45	0.4[illegible]

Poultry Manure :

The excrement from poultry is extremely variable. In general, this manure is much richer than that from other farm animals. There are two principal reasons for this: first, the food is richer as a rule: and second, the excretion corresponding to the urine of the larger domestic animals is semi-solid, voided with the dung and not subject to direct loss. Poultry manures, as a rule, are rich in nitrogen and phosphoric acid because the feeds given to them are rich in these elements. These manures are relatively poor in potash, although they may contain a larger percentage of this element than do the other farm manures. Results of analyses by different investigators are given below.

COMPOSITION OF POULTRY MANURES

	Water.	Nitrogen.	Phos. pho. Acid	Potash
Hen Manure, Fresh (Storer) ..	56.00	1.60	1.50-2.00	0.80-0.90
Hen Manure (Fresh) (Goessmann) ..	52.35	0.99	0.74	0.25
Hen Manure, Dry (Goessmann) ..	8.35	2.13	2.02	0.994
Duck Manure, Fresh (Storer)	56.60	1.00	1.40	0.62
Goose Manure, Fresh (Storer)	77.10	0.55	0.54	0.95
Pigeon Manure) (Storer) ..	52.00	1.75	1.75-2.00	1.00-1.25

Poultry manure ferments very quickly, and as frequently handled, loses much of its nitrogen in the form of compounds of ammonia, which are rapidly formed and which escape into the air unless means to prevent are taken. The mixture of poultry manures with such materials as landplaster, kainit, acid phosphate or sulpherphosphate is almost imperative for satisfactory preservation. Often dry earth or powdered dry muck are also excellent materials to mix with it. As a result of experiments carried out in the Massachusetts Experiment Station, it is concluded that the animal excreta that can be collected below the roosts per adult fowl will amount to about 30 to 45 pounds, according to the breed.

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A NOTE ON THE IMPORTED LANTANA BUG (*TELEONEMIA SCRUPULOSA* STAL.)

By J. C. M. Gardner

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In recent years reports from Australia gave promising accounts of the probable value of *Teleonemia scrupulosa* Stal. (Tingitidæ) as a lantana controlling agent, the bug having been brought to Australia from Fiji, and, after exhaustive tests, released. The Forest Entomologist requested the Chief of the Division of Economic Entomology, Canberra, Australia to send a supply of living bugs to Dehra Dun for trial. Three batches of bugs were sent by air; only the last batch survived the journey, after an ingenious method of keeping the food plant alive had been devised, and arrived in January, 1941. Especial thanks are due to Dr. J. A. Nicholson, Chief of the Division, for his active co-operation.

The Forest Entomology branch then took up the rearing of the large numbers of the bug necessary for experimentation. This presented no difficulty at Dehra Dun, large outdoor and small laboratory cages being used with special precautions against escape. For close observation, cellophane envelopes to isolate single leaves were used later.

Investigations were designed to study the bug's reactions to the local climate, its effect on lantana and above all, to discover whether the bug would confine its attention to lantana or would attack plants of economic importance, with special reference to the Verbenaceæ, to which lantana and teak, among others, belong. Incidentally Australia appears to have no Verbenaceæ of any great importance.

Dr. N. C. Chatterjee was in charge of the work from January 1941 to February 1942 and Mr. A. H. Khan from then to February 1944. I have been in close touch with Khan's work and the situation may briefly be summarized as follows. The bug definitely prefers lantana and especially its flowers, to any other plant offered. The bug is of course a sap sucker, and the effect of its feeding on lantana is that the leaves curl up, decay, and drop, this effect not being limited to the leaves actually fed upon; the flowers drop. The upper shoots of the lantana die while a new flush appears later from the lower parts. When lantana and teak are grown together in a cage, the latter is immune till the lantana is leafless when the bugs migrate to teak leaves where they can feed and reproduce, but at a slower rate. The effect on teak leaves is negligible.

The effect on teak flowers is much more difficult to assess by experiment since large trees are concerned and the isolation of groups of flowers interferes with natural conditions and especially with fertilizing agents. Experiments with muslin sleeves (flowers with and without bugs, for comparison) did not give conclusive results.

It has been found however that (1) the bugs appear to be quite happy feeding on teak flowers and once there they remain there, certainly doing the flowers no good and (2) the bugs tend to ascend stems and will therefore end at the flowers, even if not otherwise attracted to them. Presumably if the bug were released in a lantana infested area, the lantana would lose its leaves and the bug would disperse. Any teak (and perhaps other trees) in the vicinity would then be liable to attack by the bug (now changed from a friend to a potential enemy) with possible grave risk to seed-production.

I have therefore considered it advisable to close the work and to destroy our living stock of the insect. In my opinion no further living bugs should be brought into India, unless it can be definitely proved that teak flowers are not seriously affected, work that will be difficult and if considered necessary, should be taken up after the war.

A detailed account has been prepared by A. H. Khan. Incidentally answers to a questionnaire to Provincial Governments were not enthusiastically in favour of introducing the insect; there was a very proper concern as to the risk involved. One Province, the Punjab, actually values lantana as an anti-erosion agent; it would obviously be impossible to regulate the distribution of the bug by provinces.

BRITISH TIMBER INTEREST PLAN COUNTERBLAST TO ALTERNATIVE MATERIALS

By Robin Walker

(Kyle Akin, Boreland Dysart, Fife, Scotland.)

There has been so much publicity in Britain—informed and otherwise—as to the elimination of timber from many of its traditional functions to the benefit of newer types of material, that a direct counterblast from the timber trade has been long overdue. Steps are now in active progress to check the fallacy that timber is 'finished' a fallacy which the timber supply competitive interests have not been slow to discourage. The main plank of their case has been that the denudation of the world's timber sources must create a post-war shortage which will demand the use of alternative materials for the purposes normally associated with wood; or alternatively, that the required speed of output cannot be achieved while using wood, assuming that it is available, and that alternative faster methods must be resorted to.

Against these contradictory arguments certain specific assurances have been given by British timber interests, who realise the vital importance to maintain the prestige of timber as a fabricating material, a realisation which affects all the primary sources from which they draw their supplies. For only as the British merchants and organisations can convince the authorities of the soundness of their case, can growers anticipate a demand equal to expectations for their post-war lumber—and what is equally important, an adequate price. It might therefore be worthwhile reporting on the steps which the interested British organisations are taking to ensure that fair share of post war markets for lumber.

The English Joinery Manufacturers Association responsible for much of the fabricated woodwork on buildings has succeeded in getting a resolution approved by the National Council of Building Material Producers that provided adequate shipping is made available, timber will be equally available for all post-war requirements. That resolution was sent to the Minister of Works and it is significant that since then, that minister has stated publicly on several occasions that there will be ample supplies available after the war and that timber will be able to take its due place in rebuilding Britain. This association is now ensuring that all local authorities, local officials and contractors, in whose hand the specifications of the new buildings will ultimately be decided, are aware of this fact and use timber in its accustomed function. To ensure that the trade and public is equally aware, the association is planning a publicity campaign to feature standardised items of joinery work suitable for inclusion in British post-war homes. An assurance has been given by the President of the Board of Trade that the interests of joinery manufacturers in post-war timber supplies are not being overlooked: another step towards the re-establishment of the industry in its pre-war capacity.

The threat of a timber famine, raised by Sir George Courthope as an incentive to replanting, has been stated similarly by trades-

men and organisations in Britain who cite against such fears the statement by Mr. Baynes that timber reserves are inexhaustible and that there has been no destruction of forests or mills to create the slightest suggestion of a famine. That famine has, in fact been preached for the past 50 years and has not yet developed.

Timber agents in Britain are also coming to life again and adding their quota to the demands that timber shall again live as a major fabrication material. This is largely a self-interested effort, as indeed they are all, but in this case the agents have some claim to attention. Pre-war 90 per cent. of Britain's timber was imported and handled by agents based mainly on the east coast. The Canadian and U. S. trade was handled by a relatively smaller number on the west coast and London. Now with two-thirds of the national consumption home-grown, these agents have been in the wilderness for four years. They have been kept alive by the system of pooling, but only alive, and their one desire now is to see Britain again a timber consuming country. They too have therefore revived enough to urge that the timber trade is a major one and should not be shoved aside for even an attractive newer material. The hope that Sweden may be able to export soon, encouraged more than ever by the sinking, two days ago, of the "Scharnhorst," is also uppermost in their minds and an early revival of Swedish trade might not be unexpected.

More definite steps to prove that timber is a speedy material as well as a plentiful one have been taken by the Timber Utilisation Committee of the Timber Development Association. This body, concerned with the future use of timber in every sphere, has agreed to sponsor a timber house building and designing competition, without specifying the type of construction. This practical step encourages the belief that the wooden house may yet be a practical one in Britain, as it has been in other lands and is a direct refutation to the suggestion that timber is not a suitable and fast enough material for house building.

The shipping position has been disposed of by Admiral Lund who stated some time ago that the United States, after reserving a permanent merchant navy of 15/20 million tons would still have a very great surplus to dispose of. The mere fact that any nation should be discussing the disposal of a surplus of shipping surely positively settles the question of whether or not shipping will be available and this British trade authorities have not been slow to emphasise and to purposely bring to the notice of opponents who believe that a scare can be achieved on the grounds of lack of shipping.

The Timber Development Association which has been consistently given the duty and accepted it nobly, of advocating timber as a material for all suitable purposes, went into deep water in the early stages of the war when members no longer saw the need for publicity. Whenever possible effort was being made to limit the use of wood. To-day the T. D. A. has been reconstituted and re-equipped for the major battle of its nine years of life—the post-war battle. The T. D. A. has unrivalled resources for the spreading of timber publicity in Britain and is doing its entrusted job well. Timber exhibitions, timber films, and timber publicity is being placed skilfully to encourage builders, local authorities and responsible architects for future schemes, to an interest in timber as a major material in such rebuilding. There is evidence that that work is already producing results and there is little doubt but that the effort will be intensified as and when the moment comes to restart building.

The chairman, Mr. Baynes, already referred to, was leader of a deputation which visited the Consultative Council on Civil Engineering and Building to the Ministry of Works and came away with the knowledge that the timber famine bogey had been dispelled It is on the T. D. A. that much of the onus

for continued prosperity in the industry will depend and already they are on tiptoe and doing nicely in the battle.

These few quotas will serve to show lumber interests in the exporting countries that their battle is being waged as bravely as ever from this end and that any post-war drop in the British use of timber will not be due to failure to press its claims.

The position, as seen here, is that actually there will be no such drop and that maximum timber importations will be encouraged as soon as conditions are ripe for them. Labour to handle the cargoes and to use the lumber is a more definite problem in practice than is the desire to import or not, and labour availability will be a controlling factor in the amount imported and the speed with which it is imported and used.

THE ROLE OF EXPERIMENTAL RESEARCH IN THE NATURAL REGENERATION OF INDIAN TREE SPECIES BY SEED

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INTRODUCTION

Artificial regeneration has its limitations, the most serious objection being the initial outlay in money on plantations and their upkeep till the young crop is out of danger. Successful methods of natural regeneration, thus, have not only their rightful place on the score of money outlay, but also, because the subject of natural regeneration is bound up so intimately with that of forest ecology that a study of it cannot but be of material benefit to practical forestry.

The present article does not profess to put forward a rigid approach to the problem, but to list methods employed for some Indian species to enable a selection of suitable treatments for research to be made.

ASSESSMENT OF RESULTS

It looks like attempting to jump before you came to the stile to begin by talking about the valuation of results, but experience has shown that results very often prove valueless for want of a suitable yardstick to judge the superiority of a treatment. It is therefore a matter of the first importance that a standard should be set and adhered to.

The first thing to decide is what constitutes established regeneration and concomitantly what shall be regarded as recruitment and unestablished regeneration for each species. When this has been done a method has to be agreed upon for assessing the stage reached by regeneration at a given time.

The method employed in experimental silviculture in India is based on the enumeration of stocked squares. The area to be assessed is actually divided up into 6 ft. × 6 ft. squares by stretching two tapes 6 ft. apart, the squares being localised by eye. The following abbreviations are used for the various stages of the regeneration:

(1) R for recruitment. Recruitment is recorded up to 4 (in the United Provinces up to (8) as nil, R 1, R 2, R 3, R 4 according as there are 0, 1, 2, 3, 4 or more seedlings in the square, in the absence of advanced stages (2) and (3), below.

(2) U for unestablished plants. The actual height in inches of the best plant is entered for each square if there is no established plant in it, *i.e.* (3). A measuring rod 10 ft. long, graduated into feet and inches is useful for the purpose.

(3) E for established plants. Only 120 inches or whatever the limiting value is for E, is written in the form for the square concerned. All such plants are taken as having the height of the lower limit for E. With a spacing of 6 ft × 6 ft. an area will be fully stocked if it has 1,210 established plants per acre, but for practical purposes it is considered fully stocked if it has 1,000

established plants corresponding to a uniform spacing of 6.7 ft. Of course the stocking might thus appear greater than unity, but this is not objectionable in practice.

The establishment stocking factor is then calculated as follows. The heights of U plants are totalled as also of E plants. In the latter case the height of each E plant is taken as equivalent to 120 inches or whatever has been decided upon as the height of an established plant for the species concerned. This total is divided by the number of squares that contain the U and E plants to give the average height. This average height is next divided by the establishment height (120 inches or other figure as the case may be). The quotient is called the establishment factor (E. F.). Finally the E. S. F. (establishment stocking factor) is the product of the E. F. and the percentage of squares carrying U and E.

The figures for R are considered separately to amplify the statement furnished by the E. S. F. and incidentally to get an idea of the extent of mortality in the seedlings of the year.

TECHNIQUE OF NATURAL REGENERATION

The nature of the treatment to be applied to a given species will largely be based on observational data, but a good deal can be learnt from what has been attempted in the past, not only in the field of natural, but also of artificial regeneration. An instance in point is the regeneration of *Adina cordifolia*. It has been observed that innumerable seedlings of this species appear among the ashes of burnt debris, but survivals are not so striking in number in subsequent years, even complete failures being noted. What is the cause of this heavy morality? In other words what treatment should be applied to save these tiny seedlings so that they might form part of the future crop? There is no final answer to the query, but a suggestion is derived from an experiment in nursery bed shades with sowings of this very species, approximating to conditions in the forest where debris is burnt. In this experiment, with the details of which we are not concerned at the moment, a strong indication is that complete shading from the sun results in the largest number of survivals. Insolation is thus the possible enemy. This can be tested by retaining a sufficient part of the canopy to provide the shade as a possible method for experimentation.

To help in classifying problems to enable choice and selection of methods there is perhaps no better aid than to examine past accomplishments for the various species that are of importance in Indian forestry.

(The descriptions are not of a general nature as they are taken from the meagre existing examples).

ABIES WEBBIANA

Physiographic factors:

Altitude: 8,550 to 9,200 ft.
Aspect: North-East.
Slope: Very steep; 35° on an average.

Climatic factors:

Rainfall: About 50 inches mostly in July-September.
Snow: December-March.

Edaphic factors.

Black slate, schist.
Rich loam. Very thick humus from three to nine inches.

Biological factors:

Sheep and goat grazing, which is, however not heavy. Fire a danger but rare in occurrence.

Floristics:

I. *Abies webbiana, Picea morinda.*

II. *Taxus baccata, Acer pictum, Acer acuminatum, Prunus padus, Euonymus lacerus.*

III. *Cotoneaster bacillaris* (occasional), *Deutzia corymbosa, Rosa macrophylla, Viburnum nervosum, Indigofera and Strobilanthes wallichii.*

IV. *Impatiens amplexicaulis, Senecio rufinervis, Polygonum amplexicaulis, Trillium goranianmium, Fragaria vesca, Galium asperifolium, Geranium wallichianum* and *Oxalis.*

No limits for R, U and E have so far been laid down.

By definition R means seedlings of the year. There is no great difficulty in recognising them, but if there is, three inches may perhaps be taken as the lower limit of U, all plants under three inches being recorded, for each 6 ft. × 6 ft. square that does not contain the E or U stages, as R/1, R/2, R/3, R/4, as explained in an earlier section, above.

No definite limit is fixed for established plants. Three feet is suggested as the establishment height, E.

The next thing to decide is the kind of treatments likely to induce natural regeneration and to lead to establishments as nearly as possible.

The conditions of an experiment require initial comparability in plots before the application of randomised treatment. As regards seed bearers we might decide on any thing we please, but each plot will always be far from being in a position to receive an equal supply of seed from the mother trees It seems, therefore, preferable (inspite of the seeming introduction of the technique of artificial regeneration) to broadcast an equal quantity of seed in each plot and to remove the cones from the mother trees to prevent their augmenting the seed supply.

The next thing to decide is the kind of treatments for trial. Among those likely to induce natural reproduction and to lead to establishment, we might enumerate the following:

A. Manipulation of the canopy.—
 (1) 50 ft. wide strip felling, the strips running North-East.
 (2) 30 ft. wide strip felling, the strips running North-East.
 (3) 20 ft. wide strip felling, the strips running North-East.

B. Soil treatment.—
 (4) All humus removed.
 (5) Upper layer of humus removed leaving a 2″ to 3″ depth of humus over the mineral soil.
 (6) Humus left intact.

Closure to grazing would be common to all, as the fir seedling is readily browsed by goats in spring.

When reproduction has appeared, the following further treatments could be introduced.

C. Cultural operations.—
 (7) Weeding.
 (8) Soil working before the following spring.

Results of the first year would naturally be based on the estimates of R and those of the second and subsequent years on U & E.

Allowing for 60 ft. strips at the North and South to eliminate border effects, 7 replications can be arranged in an area of about 3 acres for each strip width. This arrangement will give sufficient degrees of freedom (12) for the estimation of experimental error.

CEDRUS DEODARA

Physiographic factors:

Altitude: 2,500 ft.
Aspect and slope: Flat.
Drainage: Well drained.

Climatic factors:

Rainfall: 46 inches.
Heavy snowfall: Frost occurs.
Frost occurs.

Edaphic factors:

Rock: Old river bed of various formations, predominating ones being limestones and sandstones.
Soil: Mixture of sand and clay with boulders, occasionally either pure clay or loamy soil.
Humus: Two to three inches deep.

Biological factor:

Grazing not serious locally, but heavy in the past from migrating goats, sheep and cattle.

Floristics:

I and II *Cedrus deodara.*
III *Berberis, Prunus.*
IV Grasses and herbs.

R Under 12 inches in height.
U 12 inches to 3 ft. high.
E over 3 ft. in height.

Drought and unfavourable soil conditions are the two most important causes of failure of

natural regeneration and treatments accordingly may be devised to test effects, of—

(1) Various degrees of shelter. The plot chart will show the distribution of the seed-bearers. In addition, initial comparability may be assessed on average basal area per acre of each plot.

(2) Soil working.

(3) Weeding.

(4) Light grazing.

The treatments can be tried by orthogonal arrangement, soil worked, soil not worked, weeded and not weeded, but treatments can also be superimposed, if the area of the smallest sub-plot is sufficiently large, say ¼ of an acre.

HOPEA PARVIFLORA

Physiographic factors:

Aspect: Eastern.
Altitude: 5,000 ft.
Slope: Gentle.
Drainage: Good.

Climatic Factors:

Rainfall: 65 inches from both the S. W. and the N. E. monsoon.
Frost: Nil.

Edaphic factors:

Soil: Deep loam with much humus.

Biological factors:

Exposed to damage by elephant, deer and bison.

To illustrate the method of assessment the account of an actual experiment is now given.

Summary of experimental plots nos. 42 and 43, South Coimbatore division, Madras, Karian shola, formed in Sept. 1932 and concluded in March 1940.

1. Species.—*Hopea parviflora*.

2. *Object of the experiment*—

(*a*) Will removal of *Strobilanthes* and other undergrowth including tree growth of 3 in. diameter and less (other than *Hopea* and *Mesua* saplings) and girdling of all trees (other than *Hopea* and *Mesua*) whose crowns are not in the upper canopy, result in establishing existing unestablished natural regeneration of *Hopea parviflora* by (say) 1942.

(*b*) Effect of fencing in addition to above measures.

3. *Initial condition*.—The overwood and underwood were of typical evergreen rain forest with dense *Strobilanthes* 10 ft. high. Abundant natural regeneration largely unestablished of *Hopea parviflora* with scattered natural regeneration of *Mesua ferrea*. The eastern part of the control plot (no. 42) was somewhat deficient in *Hopea* natural regeneration.

4. *Details of work carried out*.—

(a) *Initial treatment*.—*Plot no. 43*. All *Strobilanthes* and other undergrowth were cut and trees whose crowns were not in the uppermost canopy were girdled (excepting saplings and trees of *Hopea* and *Mesua*). 4 indicator plots 50 ft. × 40 ft. were laid out and *Hopea* regeneration in each counted and classified. Two of the indicator plots (nos. 2 and 4) were effectively fenced.

Plot no. 42.—Two indicator plots 50 ft. × 40 ft. were laid out and *Hopea* regeneration in each counted and classified.

(*b*) *Subsequent treatment. Plot no. 43*.—The girdled trees did not die and were therefore poisoned with "Atlas solution" in April 1933. Shrubby growth was cut and removed in 1934. It was found on inspection in 1934 that the indicator plots were neither representatives samples of the area nor did they provide a sufficient number of squares for observations. Additional 6 ft. × 6 ft. squares were therefore formed for observation. Climbers and shrubby growth were cut as necessary.

Plot No. 42.—Additional 6 ft. indicator strips were laid out as in plot 43 and 300 additional 6 ft. × 6 ft. squares formed for observation.

5. *Result*.—(1) Heights for U (unestablished) were not recorded and for recruitment, frequency symbols of o, s, f, a etc. were used. O has been taken as nil, S = ½R and f, a etc. = R where R implies 4 plants.

(2) Where a square contains E, U and R are excluded from calculations. E is

taken as 120". Copying mistakes introducing abnormal figures were corrected with approximate averages.

(3) The results are shown in the accompanying table.

(4) The indicator plots were not initially comparable, but the weightage was in the right direction.

(5) All the indicator plots of each plot were combined for analysis.

6. *Conclusion.*—There has been an appreciable increase in the establishment stocking factor, in the treated plot (no. 43) in comparison with that in the control (plot no. 42).

Plot No.		E. S. F. 1933		E. S. F. 1940	Percentage increase.
42	(control)..	30·52	..	36·89	20·9%
43	..	18·99	..	54·31	186·2%

(*a*) The removal of dense *Strobilanthes* and small trees below 3" diam. and the girdling of all trees not in the uppermost canopy has therefore has a marked beneficial effect on the progress of regeneration towards establishment, the effect becoming apparent from the 2nd year after cutting out the *Strobilanthes* onwards.

(*b*) Of the two fenced plots, nos. 2 and 4, the latter was abnormal from the start. Comparison with the former does not show great differences. Accordingly a definite conclusion has not been reached on this point, but the indications are that fencing has no special advantages.

7. *Remarks.*—Copies ledgered under S/512/Md. S/513/Md.

TABLE OF RESULTS OF ANALYSES OF THE NATURAL REGENERATION OF E.P. Nos. 42 & 43 S. COIMBATORE DIVISION, MADRAS.

Years of Observations		Jan. 1933	Dec. 1933	Dec. 1934	Jan. 1936	Jan. 1937	Jan. 1938	Dec. 1938	Feb. 1940
E. %	E. P. No. 42	12·50	15·0	15·0	17·5	20·0	20·0	20·0	20·0
	E. P. No. 43	1·25	2·50	2·50	3·75	3·75	7·50	10·00	12·5
U. %	E. P. No. 42	57·5	55·0	55·0	50·0	62·50	60·0	52·5	50·0
	E. P. No. 43	76·25	68·75	65·00	76·25	87·50	87·50	87·50	68·25
Stocking %	E. P. No. 42	70·0	70·0	70·0	67·5	82·5	80·0	72·50	70·0
	E. P. No. 43	77·50	71·25	67·50	80·00	91·25	95·00	97·50	98·75
Av. ht. in inches	E. P. No. 42	52·35	55·57	55·36	59·11	54·09	57·37	60·14	63·29
	E. P. No. 43	29·32	32·12	35·89	40·16	45·95	49·63	59·91	66·04
E. S. F.	E. P. No. 42	30·52	32·41	32·27	33·28	37·21	38·24	35·20	36·9
	E. P. No. 43	18·99	19·10	20·18	26·30	34·95	39·33	48·65	54·31
Additional R %	E. P. No. 42	28·75	27·50	26·25	26·25	13·75	12·50	16·25	17·50
	E. P. No. 43	23·12	28·12	26·88	13·75	5·63	0	0	0

It is not necessary to calculate separate figures for E and U, but this was done in the cited example to study the progress of the E's. To show how the actual calculations were done, details for Feb. 1940 are shown below, for E. P. 42.

R % was calculated as follows:

Total no. of R plants = 28

equivalent to 28/4 = 7 stocked squares

Total no. of squares stocked with R's = 7

Total no. of squares = 40

Percentage of R = 7 × 100/40 = 17·5%

E. S. F. was calculated as follows:

Sum of heights of U and E plants = 1772″

No. of squares that carried them = 28

Average height = 1772/28 = 63.29

Establishment factor = Average ht./Establishment ht. = 63.29/120 ·527

Stocking % = $\frac{28 \times 100}{40}$ = 70·0 %

Establishment stocking factor = .527 × 70.0 = 36.89.

FULL UTILISATION OF FRUITS WHEN CHEAP AND ABUNDANT—I

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A well-balanced diet is the secret of health, and particularly so with those who lead a hard life. A really strenuous life combined with a well-balanced diet will give strength and physical fitness, a smooth skin and shining eyes—a glow of health.

A well-balanced diet includes an adequate quantity of "protective foods," like vegetables, fruits, milk, etc., in addition to the starch and protein containing foods, such as cereals, rice, etc. Vegetables and fruits are called " protective foods" because they are rich in proteins, vitamins and mineral salts, and protect the body against the numerous ills which result when the diet is based on less nutritious foods deficient in these constituents. In fact, vegetables and fruits are a safety valve for dietary mistakes.

In general, diets in India are defective because they usually do not contain "protective foods" in sufficient abundance. Many people in India and elsewhere, who could afford an excellent diet, do not in fact have one. And most people could certainly improve their diets. In general, effective improvements could be brought about by wise planning, with little or no increase in costs.

Wise people always take fruit in some form in the daily diet throughout the year. But for most of us, is this possible without a considerable increase in cost? Certainly it is! Every fruit has a season when it is abundant and consequently cheap. Except for the very poor, most people can afford to buy fruit at these seasons. Now, if this cheap supply of fruit purchased during the season could only be kept to be used during the intervals between the fruit seasons, the diet would certainly be improved at those times with little or no increased expenditure.

The problem is, how to keep in good form this cheap fruit purchased during the season? This is not really a difficult problem, for modern science has shown us how to preserve fruit in one form or another for use out of season. The market (except in wartime) is full of preserved fruits, such as peaches, pears, plums, apples, etc., jams, jellies, chutneys, fruit juices and squashes. Very often, however, these have to be classified as luxuries, particularly for forest officers, who mostly have to work in places where it is impossible to obtain supplies of preserved fruits at reasonable prices.

On the other hand, home-made preserves are very much cheaper, and the forest officer often has opportunity of obtaining fruits in season very cheaply. Many forest officers, past and present, have planted fruit trees in the compounds of their forest rest houses—a very commendable practice, which is worthy of far greater extension. These trees usually

give good fruit, either annually or in alternate years, which is abundant for a short period. Very frequently also, the forest officer can avail himself of fruits grown in villages, or of wild fruits, such as strawberries, etc. which are abundant in their season.

Apart from the need of planting more trees to give an increased fruit supply, a knowledge of preserving fruit in some form or other is essential if the forest officer and his family are to spread the full use of available abundant fruit over the maximum period.

The various forms in which fruit can be preserved are:

1. Drying of fruits.
2. Bottling of fruits.
3. Candying of fruits.
4. Preparation of jams, jellies and marmalades.
5. Preparation of pickles, chutneys and sauces.
6. Preparation of juices, cordials and squashes.

Before considering these in detail, the general principles of fruit preservation may first be considered.

Principles of Fruit Preservation

The agencies which spoil fruits and fruit products and render them unfit for consumption are bacteria, fungi and yeast.

Bacteria need an alkaline medium for activity. This is absent from almost all fresh fruits, which tend to be acidic: but one has to see that the preserved material is not alkaline. This is adjusted by the addition of tartaric or citric acid, or lemon juice, whichever is suitable and available. The problem of bacteria is thus simply solved.

Yeast and *Fungi* prefer slightly acidic media, although their activity is greatly reduced in a very acidic medium. A certain minimum consistency of the product also checks their activity. Thus any fruit product with a sugar content above 55 per cent. or so and having an acidic reaction will not be attacked by fungi or yeast unless carelessly left exposed for a long time.

For products with high sugar content coupled with acidity, an additional method of preservation is sterilisation or pasteurisation of the product after capping the containers. The process is as follows:—

The bottles or containers are kept in boiling water for about five minutes in such a way that their mouths are just above the water level. This causes exhaustion of air. The bottles are then tightly capped and fully immersed in boiling water for about half an hour. They are then taken out and kept in a cool place.

A very important precaution, which must not be ignored, is that a false bottom should be provided in the wide-mouthed vessel containing the water for sterilising the bottles, without which any bottles kept in the vessel are liable to break. A towel folded to the size and kept at the bottom of the vessel will do; but the best method is to make a false bottom of wire netting for the vessel, either on a frame, or by bending the edges of the wire, so that it remains raised above the bottom of the vessel. It must, of course, be strong enough to keep raised when the full weight of the bottles to be sterilised is upon it.

The usual time for sterilisation is about half an hour, but if the product is liable to be adversely affected by heating for this time, *e.g.*, if with preserved fruit, the fruit is liable to get too soft, then the time can be reduced to as little as 15 minutes.

An additional preventive method is to obstruct the entrance of any micro-organism or spore into the bottles which is obtained by dipping the corked mouth of the bottle into melted paraffin wax. With wide mouthed bottles, the melted wax can be poured on to the top of the preserve to form a layer about one-sixth of an inch thick, and then the lid is screwed on. The paraffin wax on cooling forms an impermeable covering.

In cases of fruit products with an acidic reaction but without a high enough sugar consistency to preserve them, *chemicals* may be used to prevent the activity of any organism.

Sulphur dioxide (SO_2) is a very good preservative. With dried fruits and vegetables, they are exposed to burning sulphur fumes for about half an hour during the last

stage of drying at a temperature not exceeding 165° F. in any case (165° F. is the temperature which just causes a mild uncomfortable feeling to the hand). A common kitchen hot case is a very useful appliance for drying and fuming fruits and vegetables.

For liquid products, such as juices, cordials and squashes, *Potassium metabisulphite* is used; this liberates Sulphur dioxide gas on coming into contact with the acid medium of the product. It is added at the rate of about one ounce per 100 lbs. of liquid material to be preserved (i.e., about 700 parts per million, which is equivalent to about 350 parts of Sulphur dioxide per million parts of product. *Potassium metabisulphite* in this proportion is non-injurious and is permissible under the food laws of England. Because Sulphur dioxide has bleaching properties, it should not be used for coloured juices except when an artificial colour is added for appearance.

An alternative preservative is *Sodium benzoate*, which is used at the rate of 0.1 per cent. of the total weight of the prepared juice to be preserved. This is a common drug used by medical men for throat and cough troubles. Thus in drinks it serves as a preservative and also reacts favourably on the throat.

It is essential that the chemicals be uniformly mixed in the liquid to be preserved. To ensure this, the preservative should be dissolved separately in a small quantity of water and then thoroughly mixed with the liquid. The products thus obtained are kept in bottles or jars which have been previously carefully cleaned and sterilised in boiling water.

PREPARATION OF PRODUCTS

1. *Drying of Fruits*:

Step 1. Preparation.—Select sound fruits only, wash them, and peel and core or otherwise prepare them.

Step 2. Blanching.—With fruits which become brown due to oxidation if left exposed to the atmosphere for any length of time during peeling and coring, *i.e.*, with apples, the peeled fruit should be placed in a 2 per cent. salt solution as soon as peeled. This will prevent discoloration and will remove any slight colour occurring during peeling.

Step 3. Sulphuring.—Expose the blanched *material to sulphur fumes for the time* provided in the Dehydrating Table. Sulphured fruit must not be kept on a metal tray; wooden trays should be used.

Step 4. Drying and Dehydrating.—Dry in the sun or in a dehydrator (a common kitchen hot case can be used). If dried in the sun, care must be taken not to expose the fruit during moist weather. If dried in a dehyrator, the temperatures given in the following Dehyrating Table should be used till the product is ready.

Step 5. Sweating.—Keep the dried fruits separate to allow them to sweat out some of the residual moisture. They should be kept in a dry place, or new dry earthen pots may be used as sweating boxes.

The fruits are now preserved.

DEHYDRATING TABLE

Fruit	Form of Preparation	Sulphuring Time.	Safe dehydrating temperature
Apples	Peel and core, then make slices, cubes or rings.	30 minutes	165° F.
Apricots	Halve and pit.	60 minutes	165° F.
Bananas	Peel, halve or slice.	60 minutes	165° F.
Dates	Dip in boiling 1 % caustic soda solution for one minute and then rinse in cold water.	No sulphuring needed.	125° F. approx. (Ordinary sun temperature in hot weather will do.)
Figs	Wash thoroughly	60 minutes	150° F. to 160° F.
Peaches and Plums	Halve and pit (peeling optional)	60 minutes	150° F. to 160 F.
Pears	Peel, halve and core.	30 minutes	145° F.
Grapes	Dip in 1 % warm caustic soda solution, then rinse.	60 minutes	160° F.

Note.—In all cases, sun drying is good enough in the hot weather in India: otherwise a kitchen hot case can be used in which the temperature can be controlled by using smouldering charcoal, which should not smoke. 165°F. is the maximum temperature for dehydrating. It is easy to judge this temperature without a thermometer; if the hand is exposed to this temperature: it gives a mild feeling of discomfort.

2. *Bottling of Fruits*:

Step 1. Selection.—Select fresh, firm, properly coloured, ripe fruits, free from bruises or blemishes, and grade them according to size, maturity and colour. Over-ripe fruits should not be used, as they become too soft.

Step 2. Preparation:—

(*i*) Wash well to remove dirt, etc

(*ii*) Peel large sized fruit with a pen knife, cutting away stalks or stems in the process (*e.g.*, with apples or mangoes). Plums, apricots, grapes and other small fruits are preserved without peeling.

Peaches are peeled by dipping them into boiling 2% caustic soda solution for about ½ minute and then rinsing them (thoroughly washing). The peel can now be removed with ease by hand.

(*iii*) Any blemished portion should be cut away and the surface smoothened.

(*iv*) Cut the peeled and trimmed fruit into halves, quarters, or slices, according to the size of the fruit and of the container in which it is to be preserved. The core should be removed from apples and pears, and the stones from peaches, mangoes, etc.

Step 3. Bottling.—Put the prepared pieces in the container closely packed, and pour in hot 25% to 40% sugar solution. Cap the bottles loosely.

Step 4. Sterilising.—Keep the bottles standing on a false bottom in a vessel with boiling water nearly up to the caps for 5 minutes. Then screw the caps home or otherwise tighten them up while the mouths of the bottles are still above the water surface. When the caps have been made tight, fully immerse the bottles in the boiling water and sterilise for about half an hour (less for soft fruits like pears and apples). Then take the bottles out and keep them in a cool place.

Note.—Apples or other fruits which darken in colour during peeling as a result of exposure to the atmosphere should be placed in a 2% salt solution as soon as peeled and washed thoroughly before transference to bottles for preservation.

For every 1,000 ft. rise in altitude, 1 to 5 minutes should be added to the time required for sterilisation.

3. *Candying of Fruits*:

Mangoes, jujube (ber), apricots, peaches, plums, apples, fig, and the peel of oranges, khatta (Citrus aurantium), etc. can be used for candying. Firm, ripe and sound fruits should be selected. With citrus peel all white "rag" should be removed from inside.

Step 1. Preparation.—Mangoes, apples, pears and peaches should be peeled; other fruits may be used as they are. The fruits can be preserved whole or they can be cut into slices, or halved or quartered. Before the fruit is cut, it should be punctured all round with a small hard wooden stick or with a big thorn, like that of *Acacia arabica* (*babul* or *kikar*). The punctures facilitate the absorption of sugar.

Step 2. Softening.—Place the prepared fruit in a cloth and dip it in boiling water for 3 to 5 minutes to soften it. Citrus peel has to be boiled for about half an hour. The fruit should then be placed in glass containers or glazed earthen vessels (*amrat bans*)

Step 3. First sugar solution.—Prepare a 25% sugar solution (one cup of sugar in 3 cups of water), bring it to the boil and pour the boiling syrup over the fruit till it is

submerged. Place a heavy object, such as the lid of another glazed pot, on the fruit to keep it submerged.

Step 4. Increasing the sugar.—After 24 hours take out the syrup and add one-fourth the amount of sugar used on the previous day. Boil the syrup and pour it while boiling over the fruit.

Repeat this process every day till the sugar syrup is as thick as honey (about 75% to 80% sugar, taking 8 to 10 days).

Allow the fruit to remain in this thick syrup for 5 to 6 days to absorb the maximum amount of sugar.

If during the process any signs of fermentation are observed, both fruit and syrup should be boiled.

Step 5.—Take out the fruit and keep it in the sun to dry till the surface is glazy and dry, with large clear sugar crystals. Some dry sugar may be sprinkled on the fruit when just dry.

The fruit is now preserved as candy.

(To be concluded)

EXTRACTS

SCIENTIFIC RESEARCH IN GREAT BRITAIN

In the British House of Lords on July 20, 1943, there was a continuation of the debate on a motion by Viscount Samuel calling attention to the need for the further expansion of scientific research. Lord Dawson pointed out that "It was difficult to overstress the importance where science was concerned—and this applied equally to medicine—of preventing the enmeshment of any research body in the close entanglement of a Government department. One of the chief reasons why these research bodies should receive further support was that they succeeded in combining good order in the work of men of ability with freedom for scientific investigation."

Lord Cherwell said in part that the importance, from the economic point of view, of fostering pure fundamental research could not be overlooked.

The Government recognised that pure research must be, in a large measure, its responsibility and must be done at the universities; but naturally, they also wished to encourage industry to spend money on pure research. It was the Government's policy and intention to increase its aid for research, and it would welcome any development of industry in a similar direction. The treatment of scientists in the Civil Service had been mentioned, and he frankly admitted that the Civil Service had not hitherto shown due regard for the contribution scientists were making to the nations' welfare. This matter had now been reviewed, and an investigation had been in progress to make sure that the conditions of service, pay and prospects of Government scientific employees compared favourably with those on the administrative side. He hoped that a definite announcement on these reforms might be made before long. There were probably not more than a few dozen physicists in Great Britain capable of evolving and developing new applications of, say, the various radio devices on which success in this war very largely depended. Every one would agree that it was an anomaly to pay them on lower scales than men of equal educational status who, because they had distinguished themselves in what were usually called "humane" subjects, were often given war jobs of much higher status and pay than the scientists.—*Science*, Vol. 98, No. 2541, dated September 10, 1943.

H. E. LORD WAVELL ON INDIAN SCIENCE

Inaugurating the Thirty-first session of the Indian Science Congress, His Excellency Lord Wavell said:

"India, one of the oldest civilizations, has perhaps felt the impact of modern science later and less than any other great people. A large proportion of her population still lives the old life untouched by the vast changes of the century. Her realm has been of the spirit rather than of the earth. It may be said of the West hereafter that we took much from India materially and too little spiritually.

But if India is to play the part in the world to which her size, her population, her history and her position entitle her, she too must make every possible use of scientific advancement.

She has already produced many great scientists, she bears many more in her fertile womb. Her contributions to science have always been on the side of peace and progress. She has everything to gain by combing modern science with her old culture indeed her traditional outlook should enable her to make an increasingly fine and characteristic contribution to natural knowledge. Indian science has made in fact a very remarkable stride forward during the last twenty-five years, as is shown by the foundation of many new societies, new journals and new departments of science in universities and under Government.

In this war science has played a great role in India as elsewhere. It has made a splendid contribution to maintaining the health of the fighting men, through the activities of bodies

as the Malaria Institute, the Indian Research Fund Association, the Nutrition Laboratories at Coonoor, and others. It has also played an important part in munitions production and in solving problems of supply. As an ex-Commander-in-Chief, I should like to thank Indian science for the invaluable assistance it has given to the armies in the field.

It must play a great part also in post-war development. The coming years will be vital to India. She must learn to make use of her abundant resources with the aid of science. Science is the most international of all human interests.

Professor Hill has himself said in an address elsewhere: 'I believe that the pursuit of knowledge for the welfare of mankind is one of the greatest agents for goodwill between men in every land.' It is in that belief that he is here today.

This session of the Indian Science Congress has a momentous task to perform; to discover how best to bring the aid of science to the development of India's great resources in agriculture and industry, to the improvement of health and to social advancement and prosperity.—*Current Science,* Vol XIII, No. 1, dated January 1944.

THE TRAINING OF RESEARCH AND TECHNICAL PERSONNEL

Since the commencement of the year 1944 there have been notable utterances from the leading statesmen, industrial magnates, economists and scientific men regarding post-war reconstruction of our agriculture and industry. There is complete and wholehearted unanimity on the question of the utilisation of the immense natural resources of the country with the aid of tools offered by modern science and technology. In 1938, Lord Rutherford, in the course of his address to the Silver Jubilee Session of the Indian Science Congress, held at Calcutta, dealt at considerable length with the question of organisation of scientific research in India. He said, "This is in a sense a scientific age where there is an ever-increasing recognition throughout the world of the importance of science to national development. A number of great nations are now expending large sums in financing scientific and industrial research with a view to using their natural resources to the best advantage." The present war which has since intervened has brought into prominent relief the weaknesses in the agricultural and industrial economy of this country.

In the course of his Presidential Address to the Section of Engineering and Metallurgy Mr. Gandhy drew attention to the position of Indian industry as compared with those of the advanced countries. He said, "We are not able to manufacture aircraft or automomiles. A proper shipbuilding industry is still unknown. Our requirements of heavy machinery have to be supplied from abroad and we are content to utilise the great reservoir of scientific talent that exists in the country for the purpose of maintenance and operation of machines designed and constructed in foreign countries. What heightens the sense of tragedy is the fact that a country so unusually rich in natural resources as India should be so backward in industrial development."

Addressing the delegates of the Indian Science Congress held at Delhi, Prof. A. V. Hill spoke on the fundamental principles which guided the organisation and development of scientific and industrial research in England. In the course of this talk he referred to the four M's which are essential for the progress of science, men, money, material and machinery.

Of these, the last three could be mobilised; an enlightened and sympathetic government can enlist the enthusiastic co-operation of the public in finding the *money* and can arrange for the import of the necessary machinery to meet the urgent and immediate requirements of industrialisation. Nature has been exceptionally bountiful to us and can supply the raw *materials* needed for

industry. The supply of *men*, however, offers difficulties.

The Government of India have constituted a Post-War Reconstruction Committee which has been entrusted with the task of planning the various nation-building activities during the post-war period. A few days ago, the leading industrialists of the country have published a memorandum outlining a Rs. 10,000 crores plan of economic development for India, which is to be given effect to in three stages.

Professor Sir J. C. Ghosh, in the course of his Presidential Address to the Annual Session of the National Institute of Sciences, has pleaded for the immediate inauguration of a National Research Council with the following functions: (*a*) to plan the main lines of scientific work in accordance with national needs, to formulate schemes for the above purpose, to review and modify the same whenever necessary and to recommend ways and means for implementing the results of accomplished researches: (*b*) to ensure balanced development of all branches of science and minimise overlapping; and (*c*) to advise and help relevant authorities regarding the training and supply of scientific personnel for pure and applied research.

The speed of scientific and technological progress will be limited by the supply of scientific and technical personnel. The training of highly competent and skilled personnel takes a long period. The selection and rise of the specially gifted among these workers will follow as a matter of course. Adolph von Bayer, the celebrated German chemist, who gave synthetic indigo to the world, once said that it took three years to train an infantry man, five years for a cavalry man, seven years for a gunner and nine years for a chemist. Dr. Bhabha, in a contribution to the symposium on post-war organisation of scientific research in India, writes, "Even if money is found for equipment, a highly trained and gifted staff cannot be created in less than a decade. Professor Sir Bhatnagar is of the opinion that the National Research Council, when founded, should take upon itself the responsibility of not only planning scientific work in accordance with national needs but also help in the training and supply of scientific personnel for *pure and applied research*. Sir J. C. Ghosh has invited attention to the way in which Russia faced the problem of supply of men. "In the planning of the development of scientific research, the Soviets began with the finding and training of men and then built the Institute later. They did not start with paper plans of Institutes in which men were subsequently made to fit." Emphasis should be laid upon the finding and training of researchers who would be called upon to tackle problems of industrial advance.

Even in England, it has been admitted that the number of trained personnel is inadequate to meet the growing demands of post-war reconstruction. "Admitting that the pre-war provision for research in Great Britain compares favourably with that of the U.S.A. or of Soviet Russia, it must not be supposed that the position can be rectified immediately by the allocation of financial and material resources more commensurate with the effort required. The supply of personnel alone, as Sir Stafford Cripps observed, is an obstacle to rapid expansion."

At the commencement of the first five-year plan which Soviet Russia launched soon after the last Great War, she was faced with a similar problem. It is instructive to recall how the question was tackled by her since India is faced with a closely analogous situation. Mr. Gandhy in his Presidential Address referred to above, has outlined the scheme adopted by Soviet Russia *in mobilising their* technical personnel. "The 'peoples' Commissariat of Education as the name signifies is in charge of education. It seems that a proper scientific bias is given to education. 'Pioneer palaces' or children's clubs, with their science laboratories and their exhibitions help the growth of a scientific outlook in the minds of young students, while science courses at the schools and universities and the facilities for the conduct of research at the university laboratories in collaboration with the Science Research Institute of the Academy of Sciences,

complete the scientific training of students and turn out a regular flow of scientific workers for the benefit on the community at large."

On the eve of Russia entering the present conflict "a decree signed by President Kalinin introduced *a* system for the replacement of schools under the control of individual factories and commissariats by the Government controlled schools organised on a national plan. It was not long before a network of industrial technical schools came into existence in Russia, Moscow alone having seventy such schools towards the end of the year 1942, each specialising in a particular branch of industry.

"Offering the attraction of a free education, free uniforms, and three free meals a day and guaranteeing decent employment at the end if a diploma is obtained, these schools have drawn hundreds and thousands of youths, including girls, in their middle teens, and have already provided tens of thousands of qualified workers for war industries." Here is an illustrious example of how the talent of a whole people could be harnessed by a national government for the promotion of its industry.

Two classes of workers are needed for reconstruction, the research worker and the technician. It is generally agreed that the universities should take the responsibility of producing the researcher while trade schools and polytechnic institutes should turn out the technicians. At the moment, the universities in India are not adequately staffed and equipped, to take up the additional responsibility of producing a larger number of scientific workers; admissions to the science and technical courses are restricted due to limited accommodation and poor facilities that exist. The trade schools and polytechnic institutes are few and far between considering the size of the country and the magnitude of the work that lies ahead. Given the necessary funds there should be little difficulty in expanding the teaching and research activities of the universities and increase the flow of trained research personnel. Large sums of money should be expended for the promotion of technical schools and for the establishment of a chain of polytechnic institutes throughout the country. These schools and institutes will provide the technicians needed for the advancement of industries during the post-war period.

We must take stock of our present scientific and technical personnel. A national register enrolling all the personnel available in the country may immediately be opened either by the Department of Education or by the Department of Labour. When the war terminates an appreciable number of scientific workers and technicians will be released and the question of their absorption by science and industry should be carefully planned. These questions are best considered by a special committee which may be set up by the Central Government. Large capital grants both for university and technical education and research should be allotted. Sir J. C. Ghosh has suggested that a sum of Rs. 2.5 crores per annum should be expended for this purpose. The conditions of service should be rendered sufficiently attractive to induce the best of our young men to adopt a career of research or technology. The Government should consider the inauguration of a State Scientific Service on a parallel with the administrative Civil Service. It is earnestly to be hoped that the Government of India will give its immediate attention to this fundamental question of organising a steady supply of scientific and technical personnel for post-war reconstruction.—*Current Science*, Vol. XIII, No. 1, dated January 1944.

EX-SOLDIERS AND LAND IMPROVEMENT

BY R. MACLAGAN GORRIE, I.F.S.

The Indian Army has now reached over two million in strength and at the end of the war there will be a steady flow of soldiers back to their homes. But there will obviously be a considerable period between the signing of the final armistice and the commencement of this return.

In addition to the army, we have to reckon on a very large number of factory workers who are liable to be unemployed as a result of war supply projects being stopped. Many of these men also will wish to return to the land, because they have been recruited from their villages in the first instance and may not wish to remain on factory work when it is no longer so lucrative as it is at present.

Taking the country by provinces, the Punjab has the biggest army recruiting total. The Punjab and the N. W. F. Province together will have to be prepared to place about one million men: in the case of one district Rawalpindi, this district alone has some 70,000 men with the colours and such districts will obviously need special preparation. Bengal, Assam and Bihar together will have about half a million and in other provinces the totals are roughly in the neighbourhood of—Madras, 400,000; U. P. 300,000; Bombay, 200,000; C. P. 50,000; while the neighbouring Indian States will be in much the same ratio of their population.

Available land.—The revenue figures of each province show large areas of uncultivated waste, but actually little of this is cultivable in its present condition. Only a careful field-to-field survey would give an accurate figure for each province, and such a survey could only be undertaken by trained staff who know the potentialities of derelict land under any given set of conditions of climate, soil and water-supply. As an example, let us take the Punjab which has about 13 million acres of *barani* cultivation (that is, dependent on rains alone, not irrigation), and 14 million acres of uncultivated waste. Some, at least of the *barani* lands and much of the so-called waste is already under a destructive regime of intermittent 'subsistence' ploughing, that is, the poorest type of farming which seldom produces any useful financial return or improvement of the land. Out of these 27 million acres at a very rough guess possibly 16 million acres is capable of a higher standard of land use, but only after a great deal of terracing, *bunding* (ridging) and sub-soil ploughing has been done.

In addition, there are 4 million acres of 'current fallow' and possibly 6 million acres of land now under intermittent cultivation which, although shown in revenue returns as 'cultivated,' is actually allowed to lie fallow or derelict three years out of four but can be made fit for regular cropping if a larger percentage of the total rain could be caught and held in the soil to help to raise the subsequent crop. Taking only half of these 10 million acres as improvable, we get an overall total of improvable land of 21 million acres for the Punjab alone.

Replanning.—Similarly, in the U. P. and the C. P. enormous areas of land, now under destructive and intermittent cultivation, with gentle slopes suffering more or less continuously from sheet erosion, could be made to carry a much larger population per square mile if each field were replanned, terraced and relevelled so as to ensure a better absorption of the available rainfall, particularly in storing water in the latter half of the monsoon to make it available in the soil itself for raising a subsequent crop.

Collective Farming.—Much of the suffering and the near-famine conditions of 1938 to 1940 in Katni and similar areas of the C. P. plateau land could have been avoided by adopting some form of collective farming, the aim of which would be to bring every field to maximum efficiency in terms of water storage. Slopes must be terraced until each field retains the water which falls on it. This also applies throughout the whole of the drier parts of Bombay and Madras Presidencies and in the broken country of Bihar. In each

of the major provinces mentioned, there must be somewhere in the neighbourhood of 10 to 12 million acres requiring urgent attention along these lines, and in the major States of Kashmir, Hyderabad, Mysore, Gwalior and Baroda there is similar scope. The smaller states of the Punjab, Rajputana, Central India and Chhota Nagpur also offer vast areas for improvements. Taking 10 per cent of the net sown area, half of the current fallow, half of the cultivable waste, or a quarter of the non-available waste and 10 per cent of the village forest land, we get a total of 140 million acres for British India and 30 million for Indian States of improvable land.

Improvement of land.—Much attention has already been given by Government and the technical services to possible extension of irrigation projects. It is, therefore, proposed to deal here only with non-irrigated land, that is to say, land not at present commanded by water from irrigation canals or wells.

The best chance of allocating reasonably sized holdings to returned soldiers is where consolidation of holdings has recently taken place. Without consolidation it is more or less impossible to get compact blocks of fields. Consolidation is a long-term project and can only be undertaken by a few villages at a time and with the help of specially trained staff, so that this cannot be the solution on a very big scale. It should, however, be possible to supplement the consolidation staff already trained and speed up this movement. In the Punjab there is already a big programme of consolidation going on but other provinces are more backward.

The technique of water conservation field by field on *barani* land, and particularly on the gently rolling slopes of badly eroded uplands, cannot be handled effectively by single cultivators and must be planned on a collective basis, taking each small water catchment area as a unit for the replanning of levels and terraces. It has already been attempted in some of the Punjab districts by the Soil Conservation and Co-operative staffs working together, and in Baroda and Jodhpur by the State Departments.

Use of Machinery.—Throughout our rolling uplands there are many large blocks of land now practically unproductive which could be planned afresh in terms of run-off control, the alignment of field terraces, and the sub-soil ploughing of the fields thus relevelled. Admittedly much of this land is exceedingly poor in its present condition and any attempts by individuals to bring it under cultivation would only result in an extension of subsistence ploughing and its consequent evils. Collective action under the control and assistance of Government is the only way to ensure success, and if this help is given, we visualise the possibility of planting very large numbers of men and their families in entirely new villages in areas at present almost unproductive.

Most people think of mechanised farming as being only valuable in solving the problem of lack of manpower. The common impression is, therefore, that mechanisation displaces men from the land, but this need not necessarily be true. If the mechanical forces now at our disposal are used primarily for putting land into a condition fit for cultivation, we can get the advantage of both systems. Powerful machinery will allow us to make land cultivable by levelling and contouring on a scale that has previously been out of the question with manpower only.

It is not proposed to do the day-to-day cultivation with machinery, because a high output per man can best be obtained by preserving individual ownership and the careful attention to crops which goes with it. The combination of mechanics on a broad scale with intensive farming by the individual can combine to give us a high output per acre and this exactly what we need to ensure a good living for the ex-servicemen where cultivable land is scarce.

By means of powerful mechanical road-graders and bulldozers, many millions of acres at present yielding only irregular and unsatisfactory crops can be brought under regular and useful cultivation, the primary object being to put the land in such a condition that whatever rain falls on it will be

caught and held in the soil itself. The types of machines advised will naturally vary with the land on which we wish to establish contour farming.

The replanning of every field on the basis of contour bunds, terraces, walls or ridges is recognised as the chief principle on which water conservation must depend. There are rolling foothills with sudden alterations in slope which need stone or turf walls at frequent intervals more or less on the same lines as hill rice cultivation, but with each field forming a saucer. Next we have relatively flat land which needs broad low ridge running along the contour and laid out by means of a careful levelling survey which will take advantage of minor changes in level to dam back all the rain until it sinks into the ground.

Another type is the badly gullied lands, such as are found in the Jhelum Salt Range and along the Chambal and other ravines in the U. P. In such places a complete redesigning of the landscape is needed by throwing down the isolated pyramids of eroding soil, and laying land out afresh in terms of reasonably sized fields stepped down the slope and with drainage channels provided to deal with excessively heavy run-off. In all these types care has to be taken to provide for the very occasional, out terrific, rainstorm which is liable to break down our systems of terraces and ridges though such a storm may only occur at an interval of many years.

Almost any type of earth-moving machinery can be made use of. For the more level lands the heavy bulldozer with a broad scoop is the most economical, whereas on steeper slopes a separate trailer plough or a small scoop pulled by a separate power unit is easier to handle.

Soil Water Storage.—Having established the main lines of contour ridges for any given area so that the whole cultivable surface will trap and hold all the rain which fall on it, it still remains essential to bring the soil into the most absorbative condition and this can best be done with pre-monsoon deep ploughing. The ideal instrument for this type of work is the 'Killefer' deep ploughing attachment which has been used successfully on several farms in the Punjab and in Jodhpur State. This instrument consists of a strong and heavy vertical shaft at the base of which is a small shoe. The action of this is to disturb the subsoil layer with a shattering motion which breaks up the 2-A deep material into clods but which leaves the top soil relatively undisturbed and still on the top.

The advantage of this as compared with any over-turning action must be obvious to those who have experienced bitter disappointments where deep ploughing has brought to the surface an unweathered subsoil. It is essential to work out the acreage per machine which can be consolidated and contoured, so that trained staff can match machine activity.—*The Illustrated Weekly of India*, dated January 2, 1944.

INDIAN FORESTER

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SOIL CONSERVATION IN THE PUNJAB

By G. D. Kitchingman, I.F.S.

(Conservator of Forests, Director, Soil Conservation Circle, Punjab.)

WORK BY THE FOREST DEPARTMENT

Summary.—The article below, which was written for the use of soldiers serving abroad or away from their homes, gives a brief outline, district by district, of soil conservation work now being done in the Punjab.

General.—Rawalpindi, Attock and Jhelum Districts

The civil districts of Rawalpindi, Attock and Jhelum form an area in which the problem of erosion is of the particular type known as "Plateau" erosion. A vast plateau, about 1,000 feet above the general level of the plains to the south, is being gradually converted by the senselessness of man to a wilderness of ravines.

Anyone travelling in the train from Jhelum to Rawalpindi can see for himself what is happening by merely looking out of the carriage window: between Dina and Taraki the lower hills are bare of vegetation, and onwards the old plateau is being eaten into by countless gullies and ravines.

2. Forest officers estimate that over 1,000 acres of cultivation are being lost each year in the Jhelum District alone.

3. This big area—the Salt Range and the table land to the north as far as the outer Himalayas—is of great interest climatically because it formed, in the past, an ecological barrier against the advance of the arid desert conditions pushing up from Sind and the Indus Plain. Deforestation of the main Salt Range in the last hundred years has however allowed the desert conditions to penetrate; the torrents—flowing from the northern face, such as the Bunha, Sauj and Gahan are spreading wastes of sand over cultivation below; and the plateau itself, especially in the catchments of the Haro, Sohan and Sil rivers, is being remorselessly eaten away by a maze of minor torrents. The Grand Trunk road between Hasanabdal and Hatti passes through an area typical of plateau erosion.

4. Counter-erosion work was not started in this plateau zone until 1936, when a forest officer was put on special duty. Since then three soil conservation divisions have been formed and work is steadily increasing.

Soil Conservation in the Attock District

5. The climate of the Attock District is hot and dry in summer, and cold and dry in winter; rainfall, spread very unevenly over the year, is only 21" a year and irrigation possible only over a very small area: hence the need (if agriculture is not to fail) of retaining as much rain as possible in the soil. But this is very difficult because the tract consists of plateaux cut up by ravines and long low limestone hills only scantily covered with degraded scrub forest.

6. These climatic conditions limit natural vegetation to the most hardy species only, and the practice of browsing camels, goats and sheep intensifies these climatic conditions and further depresses the vegetation of the tract. Indeed, over vast areas of waste land the tree vegetation is only represented by widely spaced clumps of *kau* or *phulai* bushes. The district contains over one million acres of unculturable waste which could, if it were properly managed, produce many lakhs worth of fodder grasses.

7. The Forest Department started soil conservation propaganda, in addition to its ordinary duties of protecting State forests, in 1939 when lectures were given in villages and special demonstration areas started.

8. There are two types of erosion to combat: the plateau type (previously alluded to) and that caused on the low hills by over-felling, over-grazing and over-browsing.

9. "Where rain falls, there it should stay until the farmer has made all the use of it he wants." This is a true saying, and the only way to make full use of the rain water in plateau erosion is to terrace and "watt' the fields; and in villages where the fields are not properly terraced and 'watted' erosion goes on unchecked, ravines cut back, and more and more fields are destroyed. In the short time it has been doing soil conservation the department has succeeded in persuading zamindars to do *watbandi* over 1,100 acres, to terrace 700 acres and to repair old watts over 500 acres. On account of shortage of staff the work has been limited so far to the Attock and Fatehjang Tahsils, but it is hoped to start work also in Pindigheb very soon.

10. Anyone wishing to learn how to do this terracing and *watbandi* should write to the Divisional Forest Officer, Attock Soil Conservation Division, Forest Office, Campbellpur, and ask to see over the Kot Zendi demonstration area near Bahtar.

11. In the 'low-hills' erosion tracts the first anti-erosion measure is naturally the re-vegetation of the hill-sides, for which closures have to be imposed: 838 acres have been closed so far and proposals are in hand for closing 9,000 acres. Excellent grass comes up as soon as the area is closed.

12. Anyone wishing to see the effect of this kind of closure should ask the Forest Ranger, either at Campbellpur or Fatehjang, to show him a part of the Kalachitta Forest which has been closed.

Soil Conservation in the Jhelum District

13. In this district the Forest Department has started to study the technique of correcting those hill torrents referred to in para 3 above—which do so much damage to cultivation by spreading wastes of sand. There is a "torrent training" demonstration area at Said-Sain on the Tainpura *Kas* (about a mile and a half from Dina Railway Station), and another at Murid (about 7 miles from Chakwal).

Said-Sain Demonstration Area

14. Said-Sain village had been partly washed away and the rest of its *abadi* was in danger when the inhabitants appealed for help. The District Board contributed Rs. 500/- and the Forest Department gave some money. By constructing brushwood groynes the torrent has been diverted and the danger to the village removed. Besides this, some valuable land behind the groynes has been reclaimed and planted with *shisham, kahi, nari,* elephant grass and Ipomoea. Anybody wishing to see this area should write to the Range Officer, Jhelum Forest Range, P.O. Domeli.

Murid Demonstration Area

15. Murid, a village of 550 houses, stands on the edge of a cliff overlooking the Sauj torrent and was in danger of being completely washed away; many houses and wells were already destroyed. The Forest Department has succeeded in diverting the torrent flow by means of three earthern *bunds* planted with elephant grass, and having the ends protected with sand-bags filled with pebbles. But the water in this torrent comes from a catchment area of 9,000 acres, and until this catchment is properly reclothed with vegetation Murid will still be in danger.

16. These two impressive demonstration areas show, in a striking manner, two sides of the department's work—one, that of saving existing lands and buildings from destruction and the other the production of valuable timber and firewood plantations.

Anybody who wishes to see Murid, should write to the Range Officer, Pind Dadan Khan Range, P.O. Choya Saidan Shah, *via* Khewra, N.W.R.

Soil Conservation in the Rawalpindi District

17. More than 300,000 acres of rich alluvial soil in the Rawalpindi District are being eroded, and require special treatment. It is estimated that during the last 30 years one-

tenth of the area under the plough has been rendered unploughable. The Forest Department is now maintaining ten demonstration areas to show zamindars what should be done to correct this evil, and has assisted the Co-operative Department in forming 68 Co-operative Village Forest Societies for terracing the fields voluntarily.

18. Any soldier* who wishes to see *watbandi*, etc. should write to the Divisional Forest Officer, Rawalpindi Forest Division, and ask to be shown over the demonstration area at Hachari Dalal village, where 300 acres of eroded land is being reclaimed by terracing. This village is very close to the Grand Trunk road and only a few miles from Gujar Khan town. Close to this area is Kala Phida village which has also started reclamation work. Here 210 acres are being terraced and there are 3 stone-work *bunds* which might be examined.

19. Soldiers living in the Kahuta Tehsil should call at the Forest Office in Rawalpindi and ask to visit over work at Ojarian and Bhaun. At Ojarian ravine land has been levelled and terraced and gullies dammed. At Bhaun a village *shamilat* area (badly damaged by over-felling and over-browsing) is being managed by the Forest Department on behalf of the villagers. Ojarian is alongside the main road from Rawalpindi to Murree (near mile 6). Bhaun is 3 miles from village Aliot on the motor road between Rawalpindi and Kahuta.

Soil Conservation in the Gujrat District

20. A Forest Officer was appointed in 1936, as an Assistant to the Deputy Commissioner, to act as technical adviser and carry out counter-erosion and soil conservation measures. In 1939 a special Soil Conservation Division was created.

21. The chief feature of the Department's work is the reclamation and training of the large destructive torrents (Jaba, Bhimbar, etc.) which rise in Jammu Kashmir territory, and traverse the higher parts of the district, *i.e.*, north-east of the Grand Trunk road. The work entails the closure and afforestation of *banjar bela* lands situated on the banks of the torrents (or *kasses* as they are called here), and to date about 3,600 acres have been closed and planted up with *sarut* grass and *shisham* stumps; whilst *kahi*, *anjan* and other fodder grasses come in naturally later.

Stake and brushwood *bunds* are built to restrict the channels of the torrent, and behind these *bunds* silting takes place; and on the raised ground *anjan* and other fodder grasses soon appear if the area is properly closed to grazing.

The value of the crops from fields reclaimed and of the surplus grass sold by the zamindars from these closed areas is said to be now over Rs. 12,000 a year.

22. With the help of the District Engineer, large *bunds* have been constructed to protect villages and lands from torrent action *e.g.*, Malakpur, Chak Sikandar, Chak Lala, Handa and Jalalpur Jattan.

23. The two best demonstration areas are at Kot Bela where 300 acres have already been reclaimed from the *kas*, and at Guliana 9 miles from Kharian. Anyone wishing to be shown these areas should apply to the Divisional Forest Officer, Soil Conservation Division, Gujrat.

24. Towards the Jammu border there are large areas of generally sloping ground where excellent *barani* wheat can be grown if denudation is prevented by proper terracing, and if rain-water can be absorbed in the soil and only the surplus storm-water drained off. If these things cannot be done, the fertile soil is washed by storms and lost for ever. During the last two years about 500 acres of these poor lands have been reclaimed by *watbandi*, and the best area to visit is at Ajnala, 19 miles from Gujrat and 5 miles from the Jammu border. Here many fields have been properly terraced and watted by the villagers and citrus orchards under-planted with berseem.

25. The Chief Conservator of Forests, Punjab, visited the area in February, 1942, and wrote that "The estate (Ajnala) promises to be an example to the district and a credit to

the Ajnala landlords, who are very progressive and spend their money wisely in increasing the productivity and capital value of their estate."

Soil Conservation in the Gurdaspur District

26. Soil erosion is very serious in the Gurdaspur District; especially in the Bharari assessment circle of Tehsil Shakargarh, and in that part of the Pathankote Tehsil which lies between the Chakki river and the Upper Bari Doab Canal. Counter-erosion work was started by the Forest Department in 1939 with a propaganda campaign and a number of minor demonstration areas, and has been, for the present, restricted to the Shakargarh Tehsil.

Conditions in the Bharari Circle of the Shakargarh Tehsil

27. This assessment circle covers about 150,000 acres of *barani* land of low fertility generally. The standard of cultivation is low and until 1939, unlike any other locality in the Punjab, the zamindars were utterly ignorant of any technique for retaining rain-water on their fields; and the earth-scoop (*karah*) did not exist. Cultivation in this tract is not taken seriously and large numbers of villagers migrate seasonally to the Pathankote Tehsil for rice-growing. The result in the past has been a great loss of the fertile upper soil (Socrate's *sayahi zarkhez mitti*), leading to a serious exposure of the hard and unfertile clay sub-soil below.

28. The objects of the work being done by the Forest Department are:

(*i*) To increase the fertility of the existing cultivation by conserving rainfall and surface soil on the spot,

(*ii*) To increase the area under cultivation by reclaiming ruined lands:

(*iii*) To increase the prosperity of the villagers by raising *kikar* plantations on waste lands.

Demonstration Areas

29. The Department has laid down several demonstration areas from which the villagers can learn how to do work for themselves.

In Jhamrial village demonstration area where the holdings have been consolidated and fields watted, anyone interested will be able to see the technique of terracing and *watbandi*, and the use of hemp for green manuring. Jhamrial lies about 8 miles from Shakargarh.

Chak Nihala about 16 miles from Shakargarh is a Rajput village bordering the Jammu territory. Here the flat fields above the head of a gully have all been watted and some terraced. The gully has been plugged with several brushwood dams and the run-off has been reduced.

The work of reclaiming ruined lands is best seen at Fattu Chak and Kasana village lying in the Der Cho. The whole length of the 65 miles of this cho, with its tributaries was planted up with ipomœa in the spring of 1942; 10 lakhs of cuttings were put up at a cost of Rs. 250/-. Three hundred dams and spurs were put up to reduce the flow of the torrent. The work can best be seen at Fattu Chak where about 150 acres of land have already been reclaimed.

Soil Conservation Work in the Kangra District

30. Anyone who wishes to know what work the Forest Department has done to arrest erosion and denudation in the Kangra District should purchase a copy of *The Kangra Forest Societies* written by the Financial Commissioner, Development, Mr. Brayne, in 1941. Since this was published, great progress has been made and to the end of March, 1943, 41 Co-operative Forest Societies embracing an area of 43,610 acres, have been formed, in the following villages tehsilwise: —

Kangra Tehsil.—Bahnala, Dhalun, Erla, Danoa, Ghurkari, Surah, Balol, Ghin, Sukkar, Shahpur, and Khart. Total 11 societies containing 8,083 acres of forests.

Nurpur Tehsil.—Basa Harialan, Lodhwan, Paniala, Ghandran, Indpur, Sirt, Ladori, Suliali, Sarmani, Palauhra, Ghin-Lagore, Lahru and Gangath. Total 13 societies having 16,489 acres of forests.

Palampur tehsil.—Paror, Panapri, Gaggal, Bhagotla, Kusmal, Khalet, Arla-Saloh, Punnar-Dehan, Kandbari and Ghadoral. Total 10 societies comprising 9,466 acres of forests.

Dehra tehsil.—Muhl, Gumbar, Trippal, Katrah and Paisa. Total 5 societies containing 8,291 acres of forests.

Hamirpur tehsil.—Jhaniara and Nauwan Total 2 societies comprising 1,281 acres of forests.

31. Two special Gazetted Officers are engaged on the preparation of working plans and up to the end of March 1943, 21 plans had been prepared.

32. Nineteen societies have been registered under the Co-operative Act up to the end of March 1943, and they are being managed by the villagers to the entire satisfaction of the district officers and the people with regard to the protection of the forest estate. The closures have been markedly effective and have resulted in a luxuriant growth of grass which will go a long way to meet the requirements of the right-holders. The sowing and planting of trees of fodder and economic value in the closed areas have been undertaken with good results.

33. Six central nurseries have been established at Shahpur, Panapri, Erla, Indpur, Khalet and Dhamtal for raising large stock of trees of fodder and economic value for free distribution to the villagers and for use in the afforestation of their barren wastes.

34. Next shares distributed to members on the successful working of the forest societies for the year 1941-42 have ranged from Rs. 6 in *mauza* Bahnala to Rs. 55 in *mauza* Erla to each member. The income to the societies during the last year has been still more and it is expected that the maximum share in some societies will come up to about Rs. 160 to each member. Such a handsome annual income to the villagers has greatly popularised for the formation of forest societies are coming in from all parts of the district.

35. Anyone wishing to learn further details should correspond with the Divisional Forest Officer, Kangra Forest Societies Division, Dharmsala, District Kangra. The Forest Societies Scheme is one of the first of its kind in the whole of India in which Government forests are being handed over to the villagers for management and for enjoying their income. During the last two years 17 villages, running their own forest management, have received a total income of Rs. 56,789. The scheme is thus a great boon to the district and every village should take advantage of it. It will bring more money to their children and more grass and fodder to their cattle. Their cultivation will improve because their cattle will be better fed, and their forests and *shamilats* will improve, because their management will be in their own hands. The societies which have no substantial income to meet their expenditure on planting and protection, will be financed by Government till their forests improve and the societies become self-supporting.

Soil Conservation Work in Hoshiarpur District

36. The main object of forest management in the Hoshiarpur District is to reduce the damage done to cultivation by the *chos* coming down from the Siwalik hills. During the latter part of the last century, unrestricted grazing and felling destroyed the vegetation cover of these hills, and so the rainfall (32 inches in short sharp bursts during the monsoon) brings down tons and tons of sand in devastating floods. After debouching from the hills the *chos,* no longer contained by the hillside, separate laterally, lose their velocity and deposit silt. In 1938 the Financial Commissioner, Development, wrote that over 100,000 acres of extremely fertile and valuable land had been destroyed. The object of covering the hillsides with trees and bushes is to reduce the pace of the water run-off and consequently the amount of sand brought down, and to extend the flow of water over a longer period so that the height and force of floods may be less. Attempts are also being made to fix or canalise the torrent beds and to reclaim the damaged land. Again it is hoped that these methods will result in raising the

sub-soil water level in the Bist Doab and so put more water in the wells of the district.

37. In 1902 the Punjab Land Preservation (*chos*) Act was passed by which *shamilats* in the hills could be closed compulsorily to browsing and grazing.

In 1902 the area closed to the browsing of sheep and goats (section 4) was 100,000 acres, but the area closed to grazing of cattle as well as to the browsing of sheep and goats (section 5) was only 8,585 acres. In 1934, a forest officer was put on special duty to help the Civil Department with erosion work, and by the end of 1943, the area closed under section 4 had increased to over 200,000 acres, and the area under section 5 to 64,000 acres.

38. In certain closed areas, *e.g.* Dholbaha, Chohal, Bachoi and Maili hill *shamilats*, schemes have been drawn up by forest officers for works to reduce the run-off from the Swaliks; the details of these works are as follows: —

(*a*) Closure to grazing,

(*b*) Protection of existing vegetation,

(*c*) Afforestation in the planting of grass and shrubs.

(*d*) Making of brush-wood or rubble check dams in the gullies.

39. The actual work of training the *chos* has also been started outside the hills, and village lands are now being reclaimed from the *cho* beds by planting *kana* grass, *shisham* trees, etc, and making groynes over brushwood fixed down between poles, or of live plants and cuttings.

40. The different effect of these two kinds of closure is very noticeable. The area of 8,585 acres closed to grazing for nearly 40 years is now well covered with grass as well as trees, and so is not being denuded; whereas in the areas closed only to sheep and goats grass is poor, erosion continues and the run-off is still excessive and violent. Areas still open to sheep and goats are almost bare of vegetation. It is still too soon to say how many acres of *chos* have been reclaimed, but it can definitely be said that the *chos* are now doing much less damage than they used to do. In villages whose *shamilats* have been closed money from forest produce is being obtained. It is estimated that Rs 70,000 is now the income from the sale of surplus grass.

41. It is the wish of Government that as much of this work as is possible should be done by the villagers themselves, and for this purpose over one hundred *Cho* Reclamation Co-operative Societies have been organised through the Co-operative Department, and these societies are already managing 45,000 acres of village waste lands on a co-operative basis. In the last four years, forest officers have prepared working schemes of torrent correction for over 50 villages in the district.

Soil Conservation Work in the Ambala District

42. The beginnings of counter-erosion work in the Ambala District date from 1914, when 43,508 acres of the Siwalik hills were closed under the Land Preservation (*Chos*) Act to sheep and goat browsing. The supervision of this closure remained with the Revenue Department till 1939 when it was handed over to the newly constituted Ambala Gurgaon Soil Conservation Division of the Forest Department. During the last four years the area of closure has increased to 66,377 acres, of which one third is closed under Section 5 to cattle grazing.

43. It is the aim of the Forest Department to reduce, in course of time, the violence of the torrents coming down from the Siwalik hills in the north of the district. These torrents or *chos* as they are called locally, bring down tons and tons of sand which, when deposited over the plains, destroy acres and acres of cultivated land. And the only way to reduce their violence is to revegetate their catchments, so that the monsoon, when it falls on the hills, soaks into the ground instead of rushing down madly into the plains.

44. Below the hills, the work of reclaiming lands covered by sand is being done through the agency of Village Co-operative Societies (called *Cho* Reclamation-Societies) formed for recovering lands from the sandy beds of the torrents. At present there are 95

such societies covering an area of 20,629 acres. Working schemes have been prepared by forest officers for 26 societies, and the plans prescribe the building of *bunds* to divert the torrent away from ground to be reclaimed and keep it to a definite course. Behind these *bunds* sowing and planting is done to stabilize the banks. There are two *Cho* Inspectors and nine Sub-Inspectors responsible for carrying out the schemes which are being carried through by the co-operation of the Co-operative and Agricultural Departments.

45. *Demonstration Area.*—Demonstration centres have been formed at suitable places to illustrate the methods employed by the Forest Department. Should any soldier wish to see how he should put them into practice, he should apply to the Divisional Forest Officer, Ambala/Gurgaon Soil Conservation Division, Ambala City. The two most interesting demonstration centres are at Shahzadpur and Baghwali. Shahzadpur is about ten miles from Kharar and Baghwali about five miles from Rupur.

APPENDIX

Glossary of vernacular and botanical words used in this article:—

Abadi: Village site: generally the inhabited part.

Anjan: *Cenchrus ciliaris,* Linn.

Banjar: Unproductive cultivable land.

Barani: Land dependent on rainfall.

Bela: Riverain land.

Bund: Artificial bank or dam.

Cho: In Hoshiarpur District *cho* means a hill torrent, liable to heavy floods in the summer and having a dry sandy bed in the winter.

Elephant grass: *Pennisetum purpureum,*

Ipomoea: *Ipomoea carnea.*

Kahi: *Saccharum spontaneum,* Linn.

Kana: *Saccharum munja,* Roxb.

Karah: Earth-scoop pulled by bullocks.

Kas (*Kasses*): A stream or river, or torrent.

Kau: *Olea cuspidata,* Wall. (The Indian olive).

Kikar: Acacia arabica (Willd.)

Mauza: A village.

Nari: *Arundo donax,* Linn.

Phulai: *Acacia modesta,* Wall.

Sarut: *Saccharum munja,* Roxb.

Shamilat: Village common land.

Shisham, Sissoo: *Dalbergia sissoo,* Roxb.

Watt: A bank round a field to hold up water.

Watbandi: Contour-ridging or contour-terracing in plough land. 'Benching' in American.

HELVES AND TOOL HANDLES

By V. D. Limaye, B. E. (Mech).

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THE INDIAN TOOL HANDLE INDUSTRY

Manufacturing and industrial processes require the use of various types of cutting tools and hammers and large quantities of handles made of hickory and ash were being imported into India before the war. Handles made of several Indian timbers were used locally but no really serious attention was ever paid to large-scale manufacture and substitutes of Indian-made handles. The outbreak of the present world war has, however, completely changed the whole situation. The importation of tool handles has practically stopped. The demand for them has, on the contrary, increased enormously and the tool handle industry in India has received a great impetus. Woods for making helves and tool handles require special properties. They must be strong and tough and must possess great shock-resisting abilities. They must also stand the operations of high speed machine tools in the process of manufacture and a great cry was raised all over for suitable Indian timbers.

The Forest Research Institute has tested a large number of the important Indian timber species and determined their strength and

other properties. It was easy from these data to find a number of Indian woods that are as good as hickory and superior or equal to ash as regards their strength properties. Millions of helves and other types of handles made of these woods have been supplied to His Majesty's Forces and Railway and other Departments since the outbreak of the present war.

CLASSIFICATION OF TOOL HANDLES

Many different types of handles are used in India. They can, however, be roughly classified as follows: —

Class I.—*Handles for striking tools, heavy type.*—These comprise all hammer handles of about 18 to 36 inches in length for heavy hand hammers, riveting hammers, sledge hammers, etc.

Class II.—*Axe helves, heavy type.*—These comprise large helves for $6\frac{1}{2}$ and $4\frac{1}{2}$ lbs. pick-axes, felling-axes, large mallets, beaters, etc.

Note.—*Class* II has been shown separately from Class I because in addition to toughness the timber must possess great bending strength. Also the timber must work to a hard smooth surface without picking up of fibres or splitting, as the hand of the worker has to slide backwards and forwards along these handles in the act of striking.

Class III.—*Handles and helves for striking tools of the light type.*—These comprise small hammer handles of 10 to 16 inches in length and small axe helves, mallets, etc.

Class IV.—*Handles for scooping tools.*—These include handles for spades, shovels, rakes, entrenching and earth working tools, agricultural implements, etc.

Class V.—*Handles for cutting and shaping tools.*—These are required for carpenter's tools such as planes, chisels, augers, saws, screw-drivers, files, adzes, etc.

Class VI.—Handles for such articles as brushes, brooms, mops, etc.

Class VII.—Handles for a variety of miscellaneous small articles such as hair brushes, shaving brushes, etc.

Toughness and strength are the chief considerations for selecting timbers for making handles of the first four classes and also to a lesser extent for Class V. For handles of Classes VI and VII, several common and easily available timbers working to a smooth surface can be utilized as they do not require any special strength properties.

SUITABLE TIMBERS

The following timbers have established themselves as first-class hammer handle and helve timbers and have been included in their lists of approved timbers by His Majesty's Forces and the Railway Departments.

Anogeissus pendula (*kardhai*) *Anogeissus latifolia* (*axle wood*) *Anogeissus acuminata* (*yon*), *Cynometra polyandra* (*ping*), *Ougeinia dalbergioides* (*sandan*), *Sageraea listeri* (*chooi*), *Celtis australis* (*cellis*), *Olea* spp. (*kao*), *Parrotia jacquemontiana* (*parrotia*), *Diospyros* spp. (light coloured wood of ebony, *tendu*), *Acacia arabica* (*babul*), *Grewia* spp. (*dhaman*), *Heritiera* spp. (*Sundri*), *Kayea* spp. (*Kayer*), *Dalbergia* spp. (*sissoo*, rosewood), solid bamboos etc. etc.

Many other species such as *Morus* spp. (mulberry), *Thespesia populnea* (*bhendi*), *Zizyphus jujuba* (*ber*), *Zanthoxylum rhetsa*, *Terminalia tomentosa* (laurel), are also being used during the war-time. *Anogeissus pendula* is an exceptionally strong and tough wood but is obtainable in small sizes only. Some timbers such as *sundri* are liable to develop fine cracks. Bamboo is very commonly used locally. As, however, its outer skin must not be removed in shaping, careful selection is necessary so that it may fit the hole of the tool properly without cutting.

For the handles of carpentry tools such as planes, chisels, screw-drivers, etc., such woods as *Buxus sempervirens* (box). *Betula alnoides* (birch), *Acacia* spp., *Dalbergia sissoo* (*sissoo*), *Dalbergia latifolia* (rosewood), *Gmelina arborea* (*gamari*), *Pongamia glabra*, *Murraya exotica*, *Ougeinia dalbergioides* (*sandan*), and many others are used and found suitable.

Abies spp. (fir), *Picea* spp., (spruce) *Pinus* spp. (*chir*, *kail*), *Cedrus deodara* (*deodar*),

Lagerstroemia spp. (*jarul, nana, lendi*), *Artocarpus* spp. (*aini jack*), *Michelia* spp. (*champ*), *Holoptelia integrifolia* (*kanju*) and many other timbers can be used for Class VI.

Class VII includes high class articles such as handles for hair brushes, mirrors, shaving brushes, various kinds of knives, etc. and ornamental timbers or timbers that can be easily stained are required. *Dalbergia latifolia* (rosewood), *Chloroxylon swietenia* (satin wood) *Diosdyros* spp. (ebony) *Cedrela* toona (toon), *Adina cordifolia* (*haldu*), *Saccopetalum tomentosum* (*hoom*), *Michelia* spp. (*champ*), *Chukrasia tabularis* (*chickrassy*), *Mangifera indica* (mango heartwood), *Juglans* spp. (walnut) and many others can be used.

TREATMENT AND FINISHING

Tool handles are often soaked in linseed oil or shaken in a drum with paraffin wax to give them a smooth finish and good polish and a certain amount of resistance to moisture changes. The latter method is considered to be the best, more especially if pieces of hardwood are put in the drum to help the polishing. Handles of the VIth class should be finished smooth and polished.

FULL UTILISATION OF FRUITS WHEN CHEAP AND ABUNDANT—II

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Headings of Part I:—

(*a*) Introduction.
(*b*) Principles of fruit preservation.
(*c*) Preparation of products.

1. Drying of fruits.
2. Bottling of fruits.
3. Candying of fruits.

4. *Preparation of jellies, jams, and marmalades.*

Jelly is a clear sparkling transparent product of attractive colour with the flavour and aroma of the original fruit. When it is removed from a bottle it should not flow but should quiver and should retain its shape. It should not be syrupy, sticky or gummy. When it is cut with a knife, it should be tender and yet firm, presenting a smoother sparkling cut surface.

Marmalade is a clear jelly in which slices of the peel of fruits (generally oranges and other citrus fruit) are suspended.

Jam is a product prepared by cooking the fruit and sugar together to such an extent that both lose their identity.

A. Preparation of Jelly

The constituents of jelly are:—

1. *Pectin.*—This is the most important constituent because it gives all the properties above. It is produced from protopectin present in the peels of almost all fruits, by the action of an enzyme. The rind of citrus fruits, banana peel, guavas, etc. are very rich in pectin.
2. *Acid.*—An acid content of .5 to 1 per cent of the fruit juice is essential. If it is less, *e.g.* in case of pears and guava fruit juices, any acidic salt like tartaric or citric acid can be added.
3. *Sugar.*—This can be any form of soluble sugar like cane sugar. The amount of sugar will depend upon the concentration of pectin.

Acid + Pectin + Sugar = Jelly.

Pectin is a substance which is closely related to lignin and cellulose. It is generally found in the middle lamella of the cell walls of fruits and plants. It is located in the layers of cellulose. Pectin is derived from pectose existing in unripe fruits and changes to pectin in ripe fruits. It further undergoes a change and becomes pectic acid in overripe fruits, and hence overripe fruits are unsuitable for jelly making. It can be taken out of the tissues by the simple process of boiling in water which releases it from the cell walls. A solution of pectin is thus obtained.

Care must be taken not to add too much water, otherwise the solution formed is too dilute to make good jelly as such; it has to be

boiled again to evaporate the excess of water and bring the density to proper concentration

Pectin is quite easily extracted from sour fruits but with apples and guavas, some addition of acidity helps complete extraction of the pectin. It is because of this fact that all fruits are not suitable for jelly making. The fruits for jelly should contain sufficient acid and pectin to yield a good jelly without the addition of these substances from outside, some fruits contain enough of both and others are deficient in one or the other. Fruits can be classified on this basis as follows:—

(1) *Fruits rich in acid and pectin.*—Acid varieties of apples, lemons, limes, malta oranges, grape fruit, damson plums. These all are very good for jelly making.

(2) *Fruits low in acid and rich in pectin.*—Ripe quinces, sweet guavas, unripe bananas, sweet apples. Acid is to be added to give a good jelly.

(3) *Fruits low in pectin and rich in acid.*—Apricots, peaches, strawberries, mango. Not good for jelly making.

METHOD OF PREPARATION.

Step 1. Choice of fruit.—The fruit for jelly should be sound and clean and not overripe as overripe fruit is deficient both in pectin and acid.

Step 2. Extraction of pectin:—Release the pectin from the fruit tissues by boiling. Very juicy fruits such as berries are merely crushed and boiled for about five minutes without the addition of water. Hard fruits like apples, quinces, guavas may be cut into small pieces and water added should be just enough to cover the fruit. Boil this for half an hour or so.

Step. 3. Pressing and clearing.—Press the juice out by hand or with a press. Filter the juice through a thick cloth. Allow to settle overnight and next morning siphon off the clear liquid.

Step 4. Testing of pectin.—Boiling should not be stopped till this test is properly given, *i.e.* till the concentration of pectin is enough.

Take a tablespoonful of clear juice and add to it an equal amount of 95 per cent. alcohol (Methylated spirit can also serve the purpose). The character and amount of precipitate will indicate the amount of pectin.

Juice rich in pectin gives a bulky gelatinous, almost solid mass of pectin.

Juice medium in pectin gives a few large pieces of gelatinous precipitate.

Juice poor in pectin gives a poor flaky precipitate.

Step. 5. Proportion of sugar to juice.—It depends on the concentration of pectin in the juice. For rich juice add one cup of sugar for each cup of juice, and half a cup of sugar for each cup of medium juice. Juice poor in pectin should be boiled to bring it to the proper concentration. If the sugar is less than required, the jelly will be hard because the firmness is given by the pectin.

Step 6. Boiling.—Boil the mixture of juice and sugar till it gives the tests described below:—

(*a*) *Sheeting test.*—A spoonful of jelly is taken and is held up to cool. After cooling, the jelly is allowed to drip from the spoon by tilting it. The jelly will either fall as drops or as flakes. If the drops are syrupy, the proper concentration has not yet been reached and boiling should be continued till the jelly drops as flakes.

(*b*) When the temperature reaches 221° F, jelly is concentrated to the proper consistency, *i.e.* has attained about 65 per cent sugar content. In any case the sheeting test is the only sure test. In case of guavas, the sheeting test is given much before 221° F temperature is attained. During the boiling all scum should be removed.

Step 7. Sealing, pasteurization and storage.—Pour the hot jelly into sterilised bottles and cap them immediately, after removing the scum if any. If poured into open jars and tumblers, pour melted paraffin to give a thickness of about 1/6 inch (see Principles of preservation).

B. Preparation of Jams

Jam is a product of moderately thick consistency without showing the shape of the fruit used. Jams can be prepared from all sorts of fruits like mangoes, peaches, pears, apples, apricots, plums, figs, strawberries, gooseberries, etc.

Step 1 *Selection of Fruit.*—Select ripe sound fruit irrespective of size.

Step 2. *Preparation of the fruit.*—Peel the fruit and cut it into small pieces; hard fruits should be softened by warming up before addition of sugar. Berries can be used directly.

Step 3. *Mixing of the ingredients and cooking.*—Add an equal weight of sugar to sour fruits and three-fourths of their weight to sweet fruits. In case of sweet fruits 0.5 gram of citric acid per pound of fruit is also added. Mix well and heat the mixture till a proper consistency is reached (65 per cent sugar content is attained when the mixture reaches 222° F., or the boiling-point). Stirring should not be neglected. Overheating blackens the colour.

Step 4. *Bottling and storage.*—Pour the boiling hot jam into sterilised bottles and cap them immediately.

C. Preparation of Marmalade

A marmalade is a jelly in all respects except that the fruit peels are suspended in it. Usually citrus fruits are used. Orange marmalade is the most common one. It is prepared as follows: —

Step 1. *Preparation of fruit.*—Wash a few citrus fruits (oranges, maltas or khattas) and peel off the outer yellowish skin. Cut the peel of about one-fifth of the number into thin shreds. Cover the shreds with water and boil for ten minutes; discard the extract. Repeat this until bitterness is removed from the shreds.

Oranges are not so rich in pectin as maltas and khattas, and hence it is better to use the latter. The marmalades sold in the market are actually prepared from such citrus fruits which fetch no decent price in the market, *e.g.* from khattas, which sell extremely cheaply. The white portion (rag) of the peel just underneath the yellow skin is the place where the pectin is stored in these fruits and hence in peeling off the yellow skin care must be taken to retain as much of the white portion as possible; but this does not mean that the yellow skin should not be properly removed. The complete removal of the yellow skin is essential because all the glands which produce the bitter-taste-giving ethereal oils are situated in the yellow skin and hence if it is not removed carefully, the marmalade may give a very bitter taste.

Step 2. *Extraction of juice.*—Dip the peeled fruit in boiling water for a minute or two to remove any traces of bitter oils sticking to the fruit. The fruit is then sliced by means of an ordinary knife. Add water just sufficient to cover the fruit and boil for 35—40 minutes. Strain the juice through a thick cloth. Add a little more water to the residue and take two or three extractions in the same way as the first one was taken. Keep these for about twelve hours for sedimentation. Keep, the juice from all the extractions in separate vessels. Decant the clear juice of all the extractions and test for pectin (see jelly making). Only those extractions which are rich in pectin should be mixed and the extraction too poor in pectin can be discarded without much waste.

Step 3. *Mixing of the ingredients.*—Measure the juice and add sugar according to the pectin contents (see jelly making). Boil rapidly and when the temperature reaches 218° F (just before boiling, add the shreds prepared in Step 1. Continue boiling till the sheeting test is given (see jelly making). Remove any scum that may appear during boiling.

Step 4. *Bottling and storage.*—Pour the product into sterilised bottles and seal. Keep the product in a cool place.

5. *Preparation of Pickles and Chutneys.*

Pickles are not at all difficult to prepare and every housewife generally knows the art. Pickles can be prepared out of anything. Even young bamboo shoots are pickled by many people.

Pickles escape the attacks of destructive organisms because of the salt and acid contents. Oil or vinegar is also commonly used as the liquid portion of some pickles, *e.g.* in case of mango and chillies; these also serve as preservatives apart from giving taste. With lemons, the crushed and halved fruits are kept dipped in the juice after addition of the salt and chillies. As a matter of fact there are innumerable methods of pickling according to the taste of a particular tract and hence nothing particular can be described, as a method of preparation of pickles.

Chutneys are really useful preparations because they enhance the taste of a meal to a great extent at little cost. They may be hot or sweet according to the amount of spices and sugar added. In the following, only two of the common products are described. Sauces, ketchups and all such preparations are included in chutneys.

A. Preparation of Mango Chutney

Step 1. *Selection and preparation of fruit.* —Select half ripe, firm pulpy mangoes. Wash thoroughly and remove the green peel. Remove the pulp from the stones by means of a knife or a '*ghiyakash*' (grater) reducing the pulp to small-sized shreds.

The mangoes selected should be firm like unripe ones. Otherwise the chutney may get reduced to a semi fluid pulpy preparation.

Step 2. *Proportion of sugar and salt.*—Weigh the mango pulp and add to it an equal weight of clean sugar, also add powdered salt at the rate of one chhatak for every seer of pulp. Mix well and leave the mixture alone for about half an hour. The sugar will get dissolved and will get uniformly distributed.

Step 3. *Proportion of spices.*—For every seer of pulp weigh out the following:—

(*i*) *Spices* (whole). Cardamom, black pepper, *Zira* in equal quantities ... ½ chahtak.
(*ii*) Red Chillies ... ¼ chahtak.
(These also impart attractive red colour to the chutney).
(*iii*) Onions (chopped) ... 2 chahtaks.
(*iv*) Garlic (chopped) ... ½ chahtak.
(*v*) A little bit of cloves (*long*). Mace (*jahvatri*) and cinamon.

Tie all these loosely in a muslin cloth and place in the mixture of pulp, sugar and salt after the prescribed time, when the mixture is in a fluid state due to the liberation of water from the pulp.

Step 4. Cooking.—Bring the whole mass to quick boil and continue cooking till all the water is evaporated and a solid state is attained. Constant stirring is essential. During the process of cooking the muslin cloth containing the spices should be crushed with the laddle to extract the essential oils which not only add to the taste and flavour but also preserve the preparation.

When a temperature of 221° F. has been attained, *i.e.*, the boiling-point—higher because of the dissolved sugar and salt), remove the vessel from the fire and allow it to cool.

Rosins, almonds, cocoanut shreds, etc., can be added during the cooking.

Step 5. *Bottling and Storage.*—When cool, add a little vinegar and mix well. Keep the product in sterilised bottles.

B. Preparation of Tomato Ketchup

Step 1. *Selection and preparation of fruit.*—Take fully ripe, red coloured tomatoes, wash thoroughly, trim green, yellowish, rotten and crinkled portions. Crush trimmed tomatoes with a wooden laddle in an enamelled pan and boil the crushed mass for three to five minutes to facilitate the extraction of all the pulp. Strain the crushed mass through a sieve covered with muslin in order to remove the seeds and skin.

Step 2. *Proportion of spices.*—Measure the strained pulp and weigh out the following amounts of spices, etc., for every six gallons plup:—

(*i*) Onions (chopped) ... 7 chahtaks.
(*ii*) Garlic (chopped) ... ½ „
(*iii*) Cloves (*long*) ... 1 tola
(*iv*) Spices (whole) cardamom, black *zira* (in equal quantities) ... 1 tola.

(*v*)	Mace (*jalvatri*) not ground	$\frac{1}{4}$ tola.
(*vi*)	Cinnamon	$1\frac{1}{2}$ tola.
(*vii*)	Vinegar	$1\frac{1}{4}$ seer.
(*viii*)	Sugar	1 seer.
(*ix*)	Salt	$5\frac{1}{2}$ chhataks.
(*x*)	Red chillies	1 tola.

(1 *chhatak* = 5 *tolas* = 2 *ounces*)

Step 3. *Cooking*.—Tie the spices, garlic and onions in a loose knot and place them in the pulp. Bring the pulp to a quick boil. Add about one-third of the total amount of sugar just before boiling begins and the rest later in the middle of the cooking process. Add vinegar about five minutes before the boiling is stopped. The product will be of the desired consistency when two-third of the original volume of pulp has been evaporated in the process of cooking. Remove the vessel and mix the salt well. The bag or knot containing the spices can now be removed.

Step 4. *Bottling and Storage*.—Pour the product in the bottles which have been sterilised by boiling in water for half an hour. Seal them airtight. Then pasteurise the product for half an hour (see the principles of preservation—false bottom should not be ignored). Remove the bottles and store them in a cool and dry place.

Any chutney can be prepared by almost the same process. The ingredients used in the case of the above described products may be slightly modified according to the taste.

6. *Preparation of juices, squashes and cordials*

India being a hot country, the need for cold drinks is great. Certainly a refreshing drink after a hard day's march through a forest is almost a necessity for a forest officer. As a matter of fact a greater amount of fruit can usually be consumed as drinks in the form of the juices and squashes than one usually imagines, and hence the complete methods of preparation of a few juices and squashes are described below:—

A . . . . JUICES from fruits like grapes, limes, lemons, pomegranates, tomatoes, etc. are commonly preserved; the chemical used for preservation is 0.1 per cent of sodium benzoate. The preparation is as follows:—

(*a*) *Grape juice*:—Take the grapes, wash, stem, and crush the fruit. Press out all the juice by the help of a wooden press. Press twice or thrice for complete extraction. In case of coloured grapes, add some juice to pomace and heat up *to* 160° F *to* extract colour. (160° F is the temperature which gives a slight uncomfortable feeling).

To the extracted juice add 0.1 per cent sodium benzoate and mix well. Juice can be sealed in sterilised bottles and stored.

Alternatively if sodium benzoate is not available, simply bottle the juice while hot at about 165° F and then pasteurise the bottles at 170° F in hot water (not allowed to boil).

(*b*) *Sweetened pomegranate juice*.—Wash the fruit and take the grains out. Crush them with a wooden laddle and press out the juice. Extract the colour by heating the pomace with a little juice up to 160° F. Per cup of juice add half a cup of sugar to increase the flavour and keeping quality. Add sodium benzoate at the rate of 0.1 per cent of prepared weight; mix well and bottle.

Pasteurisation can be used to preserve alternatively but if a bottle of juice preserved by pasteurisation is opened, it must be consumed quickly otherwise it will go bad.

Exact weighing of sodium benzoate is not possible in an ordinary household. Therefore a practical method is to keep small packets of a definite weighed quantity of sodium benzoate.

1 *lb.* = 16 *ounces* = 453.6 *grams*. Thus one can safely keep small packets, each containing .5 gram of the chemical, one to be used for every pound of material to be preserved (roughly one tea-spoonful weighs about 1.5 gram.)

(*c*) *Tomato juice*.—Take fully ripe red tomatoes and trim any green, yellow, rotten and crinkled portions. Crush the tomatoes and heat the mass, for 3—5 minutes for good extraction. Strain the juice separating the seeds and skin.

Bring the strained pulp to a quick boil. Add common salt at the rate of one part by weight per 100 parts of the juice. Add hot juice in sterilised bottles and seal them air-tight. Pasteurise the bottles in boiling water on a false bottom for half an hour. Remove the bottles out of the boiling water and keep in a cool dry place.

(*d*) *Lime juice.*—Take fully ripe sound limes and extract the juice by the help of a wooden squeezer. Strain the juice through a thick cloth and add 0.1 per cent sodium benzoate or 0.07 per cent potassium metabisulphite and allow the sediment to settle for 25 hours or so. A clear lime juice can be filtered off next day and bottled for future use. For getting an extra fine quality of juice or for the preparation of cordials add 3—5 parts of kaolin (china clay) per 100 parts of juice. Keep the juice in a non-corrodible vessel (*e.g.* enamelled vessels) for two to three weeks. A clear sparkling juice is obtained this way.

(*Note.*—Don't forget to add the preservative).

B . . . . Cordial from lime-juice.

Carefully separate the juice from the sediment and weigh out the following amounts of juice, sugar and water:—

(*a*) For cordial with medium sugar contents.—

Juice	...	1.0	seer
Sugar	...	$1\frac{1}{2}$	seer
Water	...	$1\frac{1}{2}$	seer

(*b*) For cordial with high sugar contents.—

Juice		1	seer
Sugar	..	2	seers
Water	...	$\frac{3}{4}$	seer

Mix the above given amounts of the juice, and water and heat the mixture just enough to dissolve the sugar or preferably dissolve without heating. Strain and add the potassium metabisulphite at the rate of 0.07 per cent for the extra amount of sugar and water added. Mix well and store in sterilised bottles.

C . . . Squashes

These are simple concentrated mixtures of juice, water and sugar preserved by a chemical or even by pasteurisation, in which case the contents must be quickly used up after opening the bottle. The mixture needs dilution with cold water at the time of drinking and no sugar need be added. In case of sweet juices or less sour juices like mango and orange, some acid salt or a juice is added to enhance the taste.

The common squashes are prepared from lime or lemons, oranges, mangoes, *jaman*, etc. Extract the juice and strain through a cloth to remove any seeds. In case of *jaman*, heat the crushed fruit for about five minutes to facilitate extraction of the juice.

After extraction of the juice weigh out the following amounts of sugar, water, citric acid and juice for the preparation of the squashes:

(*a*) *Lime or Lemon squashes.*—

(*i*) *Medium sugar contents*:—

Juice	...	1	seer
Sugar	...	$1\frac{3}{4}$	seers
Water	...	$1\frac{1}{2}$	seer

(*ii*) *High sugar contents*:—

Juice	...	1	seer
Sugar		$2\frac{3}{4}$	seers
Water	...	$\frac{1}{2}$	seer

(*b*) *Orange squashes.*—

(*i*) *Medium sugar contents*:—

Juice	...	5	seers
Sugar	...	$3\frac{1}{2}$	seers

Tartaric or citric acid or lemon juice about 3-4 ounces or 2 chhataks of acid, or enough to give a sour taste.

(*ii*) *High sugar contents*:—

Juice	...	5	seers
Sugar	...	$7\frac{1}{2}$	seers

Tartaric or citric acid or lemon juice $3\frac{1}{2}$—4 chhataks or enough to give sour taste.

In this case crush 2—4 orange peels per 100 oranges used and make into an emulsion by grinding, strain it and add to the product obtained after mixing of sugar, etc.

(*c*) *Jaman squashes*:—

Juice	...	1 seer.
Sugar	...	$1\frac{1}{2}$ seers to 2 seers.

Tartaric or citric acid 5—6 grams per seer of sugared juice.

(*d*) *Mango squash*:—

(*i*) *Medium sugar contents*:—

Juice	...	1 seer
Sugar		$1\frac{1}{2}$ seers
Water	...	$\frac{3}{4}$-1 seer

Tartaric or citric acid.—2 chhataks per seer of juice.

(*ii*) *High sugar contents*:—

Juice	...	1 seer
Sugar	...	$2\frac{1}{2}$ seers
Water	...	$\frac{3}{4}$-1 seer

Tartaric or citric acid—$3\frac{1}{2}$ chhataks per seer of juice.

Use the cheapest type of ripe mangoes of various types to give different flavours and taste. The amount of water to be added depends on the consistency of the juice

Preparation.—Having weighed out the ingredients, dissolve the sugar in water by heating it slightly. Strain and add the juice. If acid is to be added, it can be dissolved in a little of the juice and mixed well with the whole amount. As far as possible the juice should not be heated.

Add sodium benzoate or potassium metabisulphite at the prescribed rate and according to the precautions laid down in principles of preservation. Mix well and keep the product in sterilised bottles. Some edible colours can be added to make the drinks more attractive to looks.

The corked mouths of bottles should be dipped in melted paraffin. The juice and squashes so preserved will not go bad, though certain chemical reactions may take place changing the taste slightly. Old squashes do not taste very different from fresh squashes.

This finishes the six sub-divisions of various forms of preserved fruits. The methods of preparation have been given in as simple a form as possible; the preparation of these products is in fact in no way different from ordinary every-day food-cooking, and therefore, I hope my efforts to bring these methods of preservation on paper will be fully utilised—this is a work for the housewife while the work of the forest officer is to plant more fruit trees and to take an interest in fruit development.

(*Concluded*)

AFFORESTATION EXPERIMENT UNDER THE GRADONI SYSTEM IN POONA DIVISION

BY A. B. PHADKE
(Range Forest Officer, Khed)

The idea of starting an experiment on the afforestation of the arid hills in the Deccan on the lines of the Italian Gradoni system was conceived by Government during the period of the Congress Ministry. The afforestation of bare hills has been carried out in Italy on a large scale. The general method is called "Gradoni" or level terracing, which has been perfected after expensive experiments. This afforestation of bare hills in Italy is perhaps on a much larger scale than in any other country in the world. It is, however, appreciably asisted by private owners who have done much work in their own lands. The work does not consist of filling up blanks or improving of the growing stock through gradual replacement by more valuable species. It is a case of restoring to productivity the naked hill tops and sides, thousands of miles in extent that were denuded of vegetation, centuries ago, and have since been subjected to heavy erosion of the soil, desiccation and incessant grazing.

The objects of afforestation under the Gradoni system are threefold:

(1) To check the soil erosion of bare hill slopes.

(2) To increase the moisture content of the subsoil by arresting rain water.

(3) To increase the supply of timber and firewood.

The system consists of contour terracing on the slopes as may be necessary to catch and retain the greater part of rain water and to prevent loss of soil by run-off. The intensity of terracing depends upon the steepness of the slopes, the degree of aridity and other features of the soil. The general procedure is to lay out first of all the Gradonis or terraces at a horizontal distance of 50 feet or greater. The spacing in the Italian system is about 20 to 30 feet but our experience has shown that they can be advantageously spaced at 50 feet or more intervals. Such terraces run continuously along the contours except where obstructions occur in the shape of big rocks or *nullahs*. Interrupted terraces are called "Piazzuols." Where even Piazzuols cannot be made due to the rocky nature of the ground, pits are dug and plants put in them. Such pits are called "Buches". It will be understood that in the best areas where rocks are absent, there should be a regular uninterrupted series of Gradonis or terraces. In practice we are having only trenches and pits. The depth of a trench is 16 inches, top width between 40 and 48 inches and the bed has an inward slope of 1 in 3. The Gradoni when thus completed looks like a wedge shaped trench which subsequently becomes a level terrace when silt is gradually collected. The seed is sown in the middle of the sloping bed. The reason for planting in the middle, rather than at the bottom or at the top of the trench is that in a year or two the trench is gradually filled up with soil brought down the hill slopes by rain water and washed in from the banks. If the seeds were sown or the plants put at the bottom of the trench they stood the danger of either being buried under the silt or the collar and possibly a part of the root would be exposed if planted at the top. Both these conditions are detrimental to growth.

The laying out of the terraces is very important. The fundamental principle of the trenches being on the same level along the contour is to be strictly observed. If this is lost sight of, the trench instead of holding rain water becomes a water channel and instead of arresting rain water assists in its run-off. In the Italian system complicated types of levels have been prescribed but after four years' experience we have come down to the use of an ordinary spirit level To start with you have to fix your base line on which points at 50 feet intervals are marked. Then with the spirit level mounted on a 5 ft. rod the trench is laid out fixing iron pegs at the two ends of the rod and stretching a string from peg to peg. The procedure of laying out trenches is not so very difficult as it looks. After a little practice one can do about one thousand feet a day. The trenches are further supplemented by stone *bunding* of the *nullahs* (water channels) or their tributaries which the trenches have to cross. This work is called "gully plugging".

Nullahs are the worst agents for carrying silt and sand from the hill slopes to the fields below affecting greatly the fertility of the fields. Hence the main object of the gully plugging, or, in other words, stone *bunding* of *nullahs* is—

(1) to check erosion of the surafce soil on hill slopes:

(2) to stop further deepening of the *nullah* beds: and

(3) to help accumulation of silt above such *bunds*.

This operation of gully plugging combined with the work of contour trenching under the Gradoni system further tends to arrest rain water and retain sub soil moisture for a longer period consequently helping the establishment of tree plants. Accumulation of silt at the bottom of cross *bunds* allows—as experience has shown—better quality of grass to come up easily.

For the construction of cross *bunds* the sites where these are to be built have to be selected first. If the work is to be carried out along with contour trenching then the site should be as far as possible in continuation of the trenches laid out and about one foot lower than the two segments of the trenches which such *bunds* will connect, so that the water running down the existing gullies may percolate and, if in excess, may flow over the top

of the *bunds* and not run into or along the trenches. If the work of gully plugging is to be independent of contour trenching then suitable sites at about 50 to 80 feet interval, depending on the degree of steepness of the hill, be selected from the top of the *nullah*. All the smaller *nullahs* falling into the big *nullah* are to be independently *bunded* with smaller dams in addition to a big *bund* at the junction of such *nullahs*. It is to be remembered that in all cases the building of such dams should be started from the topmost portion of the hill and extended gradually to lower slopes. This checks the flow of the water at the start from developing into a torrent below and does not permit it to damage the *bunds* erected down below.

If the *nullah* to be plugged is normal and not very deep and wide a cross *bund* should be about 3 feet wide at the base with a flat top of two feet and a half, height being two feet, inner face of the dam quite vertical and the outer face having a batter of one in five. These dimensions of a *bund* will vary according to the depth and width of the *nullah* to be *bunded*. Width will increase proportionately with the height. A little foundation up to 6 inches, at times, is to be dug to enable the outer boulders to be fixed properly to avoid slipping. The dam should be built up layer by layer, packing each layer with small stones so that the height of each layer is level and the formation of any cavity in the dam is avoided and the collapse of the dam during the rains prevented.

Ordinary labour under proper supervision can be employed to construct such dams and skilled labour is not required. Due to the present wartime conditions the rates of daily wages have increased more than 100 per cent. and we have to secure labour at 10 annas per day per head which in normal days could be secured at 5 annas per day per head. With 10 annas as the rate of daily wages and the stones available at the site, a dam of 100 ft. length, 2½ ft. breadth, and 2 ft. height (500 c. ft. would cost Rs. 30 *i.e.* Rs. 6 per 100 c. ft.

Khed arid area.—The above is a general outline of the scheme. Details of the work done in the Khed afforestation area are now given.

Government in their memorandum No. 17/4310, dated the 4th February 1939, desired that bare hills in the Deccan should be afforested on the Gradoni system. Accordingly an experiment in the Poona Forest Division in the hills to the north-east of Khed in miles Nos. 28—30 on the Poona-Nasik road was proposed. The site was selected by the late Mr. R. P. Dalley, Conservator of Forests, Central Circle. Since this land was in charge of the village *panchayat* of Khed an area of 178 acres from forest S. No. 1178 was transferred to the Forest Department for the purpose of the experiment and the work was started in May 1939.

The work done during the past four years is as under:

Year	Area A. G.	Quantity of trenching and *bunding* R. ft.	Cost of work done: On trenching and *bunding* Rs.	Cost of work done: Other items of Cost Rs.	Cost of work done: Total Rs.	No. of plants
1	2	3	4	5	6	7
1939-40 ..	28-12	27,659	770	275	1,045	2,852
1940-41 ..	36-20	25,900	617	267	884	5,493
1941-42 ..	19-00	19,035	514	62	576	2,715
1942-43 ..	35-00	14,805	1,124	143	1,267	3,106
Total ..	118-32	87,399	3,025	747	3,772	14,166

The total cost per 100 r. ft of trenching and *bunding* works out to Rs. 3-7-0. Such species as were likely to thrive in the arid area were sown, the important ones being *shivan* (*Gmelina arborea*), *khair* (*Acacia catechu*). *medsing* (*Dolichandrone falcata*), *lalai* (*Albizzia amara*), *nim* (*Azadirachta indica*), *shiras* (*Albizzia lebbek*), *kashid* (*Cassia siamea*), etc. The whole area is closed to grazing, the grass that comes up is permitted to be harvested by the villagers. It will be surprising to note that where not a single blade of grass was available before 1939, approximately 30,000 lbs. of grass, on an average, is yearly available now. Attempts have been made to improve the quality of the grass by sowing better quality seed. The total area under the experiment to date is 118 acres and 32 *gunthas* terraced and *bunded*, and the total expenditure incurred is Rs. 3,772 which works out to Rs. 32 per acre.

Kharpudi Bk. Land Development Scheme.—Kharpudi is one of the villages in which a scheme under land development projects as designed by the Director of Agirculture is introduced. The amount for this scheme is being provided from Sir Cursow Wadia Trust Fund.

The objects of this scheme are the same as those for the Khed arid area and the work is carried out exactly on the same lines as at Khed with the only addition that rotational grazing is introduced in the areas under the scheme. This scheme will be a practical demonstration to the villagers as to how bare hills can be clothed with tree-growth and fertility of the lands situated at the foot of these hills maintained, by contour terracing, gully-plugging, tree planting and controlled grazing.

The *bunding* in the fields below is done by the Agricultural Department. This is only soil *bunding*.

The whole area included in the scheme is divided into two ranches 'A' and 'B' of 144 acres and 38 *gunthas* and 67 acres and 20 *gunthas* respectively. Each ranch is subdivided into five pastures and work done is in pasture No. 1 of both ranches.

Ranch 'A' Pasture No. 1.

Nature of work	*Quantity*		Cost Rs.	a.	p.
(1) Trenching	16,236 r. ft.		778	0	0
(2) Stone *bunding*	11,139 c. ft.		669	6	0
(3) Miscellaneous	..		102	8	0
		Total	1,549	14	0

Ranch 'B' Pasture No. 1.

			Rs.	a.	p.
(1) Trenching	7,921 r. ft.		280	0	0
(2) Stone *bunding*	8,148 c. ft.		391	4	0
(3) Miscellaneous	..		55	0	0
		Total	726	4	0
		Grand Total	2,276	2	0

All the above work was done by employing labour on daily wages at annas 10 per day. The estimated cost per 100 c. ft. of trenching is Rs. 5 and that for gully-plugging is Rs. 6 per 100 c. ft. The cost incurred to date works out to be Rs. 50 per acre in ranch 'A' and Rs. 55-13-0 per acre in ranch 'B'.

Sowing was done between 10th and 13th June, 1943 and the seeds of the following species have been sown.

1. *Nim (Azadirachta indica)*
2. *Shivan (Gmelina arborea).*
3. *Khair (Acacia catechu).*
4. *Shiras (Albizzia lebbek).*
5. *Karanj (Pongamia glabra).*
6. *Ber (Zizyphus jujuba).*
7. *Kinhai (Albizzia procera).*
8. *Tarvad (Cassia auriculata).*

Pasture No. 1 is strictly closed to grazing for eight years. The other four pastures of each ranch are rotationally grazed by the villagers and the benefit of such grazing and the improvement in quality and quantity of grass is being watched.

These are the details of the scheme and that of the works carried out in Khed arid area during the past four years and at Kharpudi during the present year. No doubt the schemes are superb but one has to think whether it is possible for the ordinary cultivator to undertake such costly schemes. Any ambitious and comprehensive scheme of reboising the bare Deccan hills is bound to founder on the financial rock. Nor is finance the only rock on which such schemes are likely to come to grief. Equally formidable is the work of popular apathy and non-co-operation. These hills were not bare and arid since the beginning. But with the increase of population and decrease of the sense of responsibility, the villagers misused the existing vegetation, both trees and grass, the first by unregulated hacking and the second by excessive grazing. What guarantee can there be that the hills re-clothed under ~~the scheme~~ will not revert to their present condition as soon as the special guards on the experimental area are removed? Even a full complement of guards is found to be insufficient to stop the steady destruction of forest as every one of us knows. Hence no improvement is possible without the willing co-operation of the public. Given that co-operation, improvement is not only rapid but inexpensive.

Any efforts therefore on the part of the Forest Department however far-reaching and commendable they may be are negatived if there is no active co-operation from the villagers. Forests are a valuable national treasure which Nature has given and the benefits accruing from the judicious use of its products are incalculable. The prosperity of the people is directly and indirectly connected with the welfare of the forest wealth. If forests suffer it has an adverse effect not only on the vegetation but on climate, rainfall, soil, agriculture, cattle, etc. So every effort must be made to educate the masses and to awaken in them a sense of responsibility towards the forest both by the members of our department and by public-minded people through intensive propaganda. This alone will insure success for schemes like those undertaken at Khed and Kharpudi.

EXTRACTS

HARNESSING "LOST RAINFALL" FOR CROP PRODUCTION

BY WILLIAM J. JENKINS, C.I.E.

(Director of Agriculture, Bombay Province)

Summary.—By contour bunding and scientific dry farming methods, the Government of Bombay is launching a great campaign to fight recurring famines over large tracts of the "dry" areas of the province. Every effort is being made to utilize the "lost rainfall" for profitable crop production and also to check the severe annual loss of fertile surface soil. In the accompanying article, the author tells us how all this is being done.

In the province of Bombay by far the greater proportion of crop production is solely dependent upon the adequacy, timeliness and distribution of the monsoon rains. Only one acre out of every 30 under cultivated crops in the province is under artificial irrigation from canals, tanks or wells.

In the Deccan tract, which includes the districts of Bijapur, Sholapur, Ahmednagar, Poona and Satara, the cultivators are constantly faced with the probability of seasons when rainfall is scanty and badly distributed Part of this area, mainly in Poona and Ahmednagar districts, is protected from the vagaries of the monsoon by large canal irrigation works. The remainder of the tract, however, remains dependent upon the monsoon rains for its successful crop production.

This "dry crop" tract has earned unenviable notoriety as the "scarcity area" of the province, an area in which seasons of partial or total failure of crops, due to inadequate or maldistributed rainfall, occur, on an average, about twice in every four years.

The recent famine conditions in Bijapur and Sholapur districts are fresh in the minds of the public. In these districts crop cultivation is mainly carried on in cold weather and is dependent upon satisfactory rainfall in August and September. The chief crop is *rabi jowar.* If an early monsoon is experienced, and soil moisture becomes adequate for sowing *bajri*

is grown in the shallower soils in the *kharif* season; but, as a rule, the bulk of the cultivable lands are reserved for *rabi* or cold weather crops.

Wrong Impression.—As a result of constantly recurring famines and "scarcities" in the Bijapur and Sholapur districts, there has airsen a general impression that the rainfall in these areas is almost always inadequate for crop production and that the only hope of their salvation rest in a great extension of artificial irrigation works by the construction of a large system of canals supplied by perennial rivers such as the Bhima or the Krishna, or by storage reservoirs constructed in the Western Ghats.

Apart from the fact that the economic possibilities of such major irrigation works in this tract is extremely doubtful, is this view correct? The rainfall statistics show that over a period of roughly 60 years, the average total rainfall in the Bijapur district has exceeded 20 inches per annum, and in the Sholapur district 25 inches per annum. These quantities of rainwater are, in the aggregate, considerably more than necessary to bring to full maturity excellent crops of *kharif bajri* or *rabi jowar*.

There must, therefore, be some other reasons than inadequacy of total average rainfall per annum to account for the constantly-recurring crop failures in the districts under consideration. Nature herself provides a clue. No one who has visited the fields of the cultivators in Bijapur and Sholapur districts—and in other dry cultivated tracts of the Deccan—can fail to be impressed by the ever-present evidence of soil erosion and denudation, commencing on the treeless upper hillsides and growing in extent and intensity through the cultivated lands on the lower and more fertile slopes. This evidence of destruction of the cultivator's capital, the soil, is a clear indication of the "lost rainfall" which, instead of becoming an agent of production in crop cultivation is, indeed, a veritable agent of destruction, denuding the sloping lands of their covering of soil and washing down the fertile upper layers of the tilled fields to irrecoverable lost in *nullahs* and rivers.

In the famine and "scarcity" areas of the Bombay province, the monsoon seasons are often characterised by heavy downpours of short duration. Such downpours are often of little use in crop production as much of the rainwater is not retained in the soil but rushes down the unprotected fields to natural drainage channels, carrying with it tons of soil and creating ever-widening and ever-ramifying gullies throughout the agricultural lands.

The losses of fertile soil by such erosion must reach a colossal total annually. Experimental work carried out over a number of years at the Dry Farming Research Station, Sholapur, has shown that, on an average, about 20 per cent of the total rainfall is lost annually by run-off, and what is more serious, the losses of soil on cultivated lands per annum as a direct result of such run-off amount to approximately 35 tons per acre.

The Remedy.—The problem of crop cultivation in such scarcity areas is, therefore, of a two-fold nature. In the first place, it is essential to adopt measures which will result in the fullest use being made of all available rainfall in crop production. Secondly, steps must be taken to restrict the enormous loss and damage caused by erosion due to the run-off rainwater after heavy precipitations over unprotected hill slopes and cultivated fields.

In short, the rainfall must be put into the soil and retained there for the use of crops. The "lost rainfall" must be harnessed for crop production, and its power to damage and denude the agricultural lands of their "crop factory," the soil, must be checked.

Experimental Work in Bijapur.—In the course of his recent visit to Bijapur district, the Viceroy had an opportunity of inspecting the work being done by the Agricultural Department to cope with this ever-present threat of famine and crop shortage. This work consists of (*a*) contour bunding, and (*b*) introduction of scientific dry farming methods.

During the recent famine in the Bijapur district, the Government of Bombay undertook a large scale experiment on 'contour bunding" in that area. Contour bunding means the construction of small field bunds across the slope of the land and along the natural contours to

check the unrestricted flow of rain-water down the slopes and thus to facilitate the soaking of rainfall into the soil where it will be held and utilized for crop production.

The work done in Bijapur was experimental in the first instance, and had the advantage of providing valuable constructive work of permanent utility to the district for large numbers of famine labour. The Land Development Section of the Agricultural Department was strengthened by the addition of a charge known as the "Scarcity Areas" which was entrusted to Mr. V. A. N. Sausman, an experienced officer of the Bombay Forest Department, who had made a special study of land development and anti-erosion work in other parts of India.

Excellent Results.—The large-scale experimental work on contour bunding was commenced in April, 1943. Up to the end of January 1944, this work had been completed over 1,00,000 acres divided among 27 large bunding projects. The total protected area includes 25,000 acres of forest and waste lands generally found at the top of the water-sheds and which have been contour-trenched and are now being reafforested with suitable types of trees.

In the district, the area of agricultural land now protected by contour bunding exceeds 1,25,000 acres. More than 2,500 miles of contour bunds have already been erected and the constructional work has involved 250 million cubic feet of earth work. In August 1943, over 39,000 famine labourers were engaged in the erection of contour bunds, but this number declined later on account of the favourable rains in September-October, 1943, which resulted in many famine victims returning to the cultivation of their own lands.

The results of the work done indicate that contour bunds with a base of 6 ft. and a height of 3 ft. spaced at every 3 ft. drop in contour level are the most economic and effective type of anti-erosion measures in the district. Such a system of contour bunding does not require the provision of waste weirs in the bunds as the "compartmentation" of the area by the bunds has proved adequate to hold all the precipitation and enable it to be absorbed gradually into the soil and subsoil.

The bunds were fully tested from September 15 to October 15, 1943, when some parts of the district received an unprecedented rainfall, totalling about 15 inches. In such areas, the contour bunds constructed by the Land Development Section held up the surface run-off and remained sound and unbreached. The cost of the work is now being accurately determined by skilled accountants and is not expected to exceed Rs. 12 per acre over the whole protected area in the district. The Land Improvement Schemes Act, 1942, recently enacted by Government is intended to be used to ensure that the contour bunds erected with the assistance of Government are maintained and preserved in good condition by the land owners whose lands they benefit and protect.

Dry-Farming Methods.—The second phase in this campaign against famine and scarcity consists of the introduction and extension of scientific dry-farming methods over the areas which have been protected by contour bunds. Research work on problems of dry-farming has been carried on during the past ten years at Dry Farming Research Stations at Sholapur and Bijapur, financed jointly by the Government of Bombay and the Imperial Council of Agricultural Research. These investigations have been conducted by expert staff of the Agricultural Department under the Soil Physicist to Government which post was held by Professor N. V. Kanitkar until March 31, 1942 and thereafter, by Dr. V. N. Gokhale.

The main result of these important scientific experiments and research work has been the evolution of the "Bombay Dry Farming System" which is a simple method of land preparation, tillage and crop cultivation designed to ensure the conservation of the bulk of the available rainfall in the soil and subsoil and its retention there for the use of growing crops over as long a period of time as is necessary for their development to full growth.

The main factors included in the "Bombay Dry Farming System" are, in addition to contour bunding of the land surface, modifications in local agricultural practice connected with soil tillage, especially interculturing of crops, the extension of manuring, particularly green manuring, the introduction of scientific

systems of crop rotations and fallows and the cultivation of drought resistant varieties of the major crops.

It is not possible within the scope of this article to enter into detailed descriptions of the component "factors" of the system, but during the past nine years at Bijapur the average yield per acre from areas cultivated according to the improved method has been 445 lb. of *jowar* grain and 623 lb. of *jowar* fodder (*kadbi*) as compared with yields averaging 224 lb. grain and 406 lb. fodder on adjoining fields cultivated in accordance with common local agricultural practices. In the year 1936-37, which was one of great scarcity over the whole of Bijapur district, fields cultivated in accordance with the "Bombay Dry Farming System" yielded under the most adverse conditions, that is, a total rainfall of 13.24 inches or 60 per cent of normal, 470 lb. of *jowar* grain and 711 lb. of *jowar* fodder per acre. In the recent 1942-43 severe famine in the district, the area of the Bombay Dry Farming Station at Bijapur gave average yields of 240 lb. grain and 450 lb. fodder per acre and appeared like an oasis of crop growth amidst a desolate and barren countryside.

The Dry Farming staff attached to the Land Development Section of the Agricultural Department is now busily engaged in the introduction of scientific dry farming methods on the contour bunded areas, and up-to-date over 8,000 acres have been cultivated in accordance with the methods advocated under the "Bombay Dry Farming System" in the district.

Thus the Government of Bombay, in co-operation with the cultivators of the "scarcity" areas, is launching a great campaign to fight recurrent famine and distress over large tracts of the "dry" areas of the province. The main weapons being used in this struggle are contour bunding and scientific dry farming methods applied on the widest possible scale. The "lost rainfall" is to be utilized for profitable crop production and the severe annual loss of fertile surface soil is to be checked.—*The Illustrated Weekly of India*, dated March 5, 1944.

YIELD OF WATER AS AN ELEMENT IN MULTIPLE USE OF WILD LAND

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Service as watersheds is one of the most important contributions that wild mountain lands make to the economy of the semiarid West. Their utility for watershed purposes is influenced by a number of factors, of which those associated with the kind and density of vegetation may be manipulated in coordination with other uses to obtain optimum yields of usable water. Since the benefits of land management for water yield may often be less direct than the returns from other resources, land managers are cautioned to guard against subordinating watershed services to other uses at the expense of the public welfare.

Throughout the semi-arid West, the most important service of wild mountain lands is in their utility as watersheds. This statement needs little amplification for any informed and observing westerner, who appreciates only too well the intimate relation between mountain water supplies and valley enterprises.

He realizes the significance of the fact that 19 to 20 million acres of land in the western United States are irrigated. He knows that this is the most highly productive and valuable land in the region, worth approximately 5 billion dollars, together with its buildings and machinery. He has frequently seen and comprehends the place of the many irrigation, water-storage, and distributing systems with a current value of well over 1 billion dollars. He knows that water is applied over and over again as it flows along its course until none

may be left in the stream. He sees farmers and ranchers destitute in years when irrigation water fails. And he is reminded each day that the great irrigated agricultural empire is intimately associated with and dependent upon the yield of water from mountain watersheds.

The western city dweller is no exception either. He is fully aware that his lawn, his garden, or even his drinking water depends on the snow in the mountains. He knows that the size of his city and its industries are controlled by the water yield from tributary watersheds. He is probably aware that cities like Colorado Springs have paid as high as $50,000 per second foot for water rights; that Denver had had to bring water through the Rocky Mountains at a cost of several millions of dollars; that Salt Lake City protects its mountain watershed as conscientiously as it does its city hall; and the Los Angeles is concerned greatly with watershed conditions on the Colorado River and their effects over the water delivered from this stream to metropolitan areas in southern California.

In brief, the essence of the situation is that arid western valleys have, except for adequate rainfall, all the resources necessary to support intensive agriculture with attendant populations and industries; surrounding mountains, on the other hand, which lack in many essential elements, have surplus rainfall. Fortunately, the topographic relation of the two is such that the surplus moisture from the higher elevations gravitates to the valleys where it supplies the single missing element essential to produce and maintain the thriving civilization which exists. The two together—mountains and valleys—constitute a productive union, with water as the vital connecting link.

This fundamental relation of the western mountain watersheds and valleys has been recognized since earliest pioneer days, and the first forestry and conservation movements were predicated on it. Several national forests of the West were established primarily for watershed protection, rather than for the more conventional object of timber production. In the rush of economic development and resource utilization, however, this relation is sometimes forgotten even locally, and on a national scale lack of familiarity with conditions often causes serious misunderstandings. For this reason it is desirable to recount and emphasize the importance of mountain watersheds for the benefit of those either directly or indirectly associated with wild-land management, regardless of where they are located.

The Basic Watershed Factor.—The service that a watershed performs is expressed by the amount and regularity of stream-flow which it yields. This stream-flow is influenced by a variety of natural watershed characteristic chief of which are climate, geology and soil, topography, and vegetation.

These watershed factors and their specific influence on water yield have been frequently described. It has been pointed out how climate determines the amount of water reaching the watershed; how geology and soil guide the disposition of water after it reaches the earth; how topography influences precipitation, runoff, and soil stability; and how vegetation both conserves and uses water as well as stabilizes soil. Of all these factors, however, vegetation is the only one which can practically or appreciably be modified by human activity on any large scale for beneficial regulation of water supply.

As vegetation is the chief natural watershed factor subject to manipulation by man it logically follows that multiple land use and management must concern itself primarily with this factor. In handling watershed lands, therefore, land managers must concentrate primarily on a thorough understanding of plant-water relationships and translate any action taken into its effect on these relationships.

Vegetation and Watershed Management.—How does vegetation function in the regulation of water yield? On one side of the ledger, it consumes water by transpiration in large quantities and it intercepts substantial amounts which are ultimately lost by evaporation. On the other, it holds the soil in place and tends to make it more permeable; it covers the ground with organic matter which

functions to promote infiltration and reduce erosion; and it shades the ground, reducing local evaporation.

Preliminary studies in the lodgepole pine type along the Continental Divide in the central Rocky Mountains, for example, indicate that the average amount of water stored in snow in the early spring on cutover areas may be 40 to 50 per cent. greater than under virgin stands; and that heavy timber cutting may reduce the draft on soil water during the growing season by $1\frac{1}{2}$ to 2 inches. Thus in this area, where erosion presents only slight hazards, heavy cutting of lodgepole pine may exert very beneficial effects on water supply. If, on the other hand, flood control happened to be more important than water yields, an uncut forest should keep the watershed in a desirable condition by reducing the precipitation available for runoff and by preparing the soil to store the maximum amount of water.

With a heavy cover of vegetation —whether forest, brush, or grass—the soil mantle is stable, flashy surface or subsurface runoff is minimized, and streamflow is relatively constant in rate, but may be lower in quantity than desired because of excessive use by transpiration and loss by interception. On the other hand, too light a plant cover provides insufficient watershed protection, and although relative water yield may be large in quantity from any poorly vegetated area, it tends to occur in abrupt and flashy peak flows, loaded with eroded material which often makes the water unusable and results in costly siltation of reservoirs and other stream improvements. On the Wasatch Front in Utah, for example, destructive floods and high rates of erosion have followed heavy grazing which depleted the plant cover. In southern California the burning of chaparral cover on mountain watersheds has been followed repeatedly by heavy runoff of torrential rains, loaded to capacity with debris, while near-by unburned watersheds have developed only minor peak flows of relatively clear water.

For each watershed there is an optimum range of plant cover conditions, within which the soil mantle is protected and desirably distributed quantities of water are yielded. This optimum condition does not depend solely upon the character of the watershed itself; it depends also on the object of watershed management and on other needs. As indicated previously, where flood control or other regulation of water supply is the dominant object, the heaviest possible plant cover might be best. For maximum water supply, with reservoirs available to store flashy runoff, the lightest possible cover of vegetation compatible with soil protection might be desirable. And where other uses such as grazing or timber production are more important than water, watershed requirements might be subordinated if necessary to meet the more evident needs of these uses. Every watershed is unique as to detail; but in general the prevailing objective of management of the plant cover should be to obtain the most desirable yield of water as to both quantity and quality, in harmony with the needs of all other essential uses and services.

Multiple Land Use and Watershed Management in the West.—Except for certain special areas, a prevailing philosophy of multiple use should and does guide the management of western wild lands. This means that watershed service must be co-ordinated effectively with other uses so that a maximum contribution to the local and national economy can be realized from the land. For the most part this co-ordination of watershed management with management of other resources may be easily and effectively achieved. To do so, however, requires a general understanding of the relation of other resources to water.

Forests and Water.—While trees produce timber and may conserve water and soil, they also consume or dissipate water in large quantities. Thus, in planning forest management for water yield, a balance sheet must be drawn to evaluate the probable relative effects of any action undertaken upon water supply and other resources.

Ordinarily the relation of forests and water is such that timber and water yields may be effectively harmonized. Stands may be arranged not only for silvicultural purposes but to reduce interception of snow and rain and at the same time effectively regulate its

melting or runoff. For example, in the lodgepole pine type, it appears that rainfall reaching the ground in a mature stand will increase about 0.10 inch for each foot increase in the radius of canopy openings up to 18 feet, owing to reduced interception. Almost always the relation between the unmanaged forest and water yield will be such that the latter can be improved by desirable silvicultural treatment.

One point which should be emphasized is that trees are not necessarily the best ground cover for water yield. On watersheds where engineering structures control runoff effectively, as they do on several western streams, there may be little need for the regulatory function of trees on streamflow. A stand of lesser vegetation, such as grass, that suitably controls erosion may use less water than the trees and therefore be a more desirable cover.

The general relation of trees and water is such that where regulation of streamflow is the major consideration, crown openings should probably be held to a minimum size; and where maximum water yield is the main consideration, cutting should be carried to the limit prescribed by acceptable silviculture. Only the local land manager, thoroughly familiar with his total resource, can be expected to prescribe exact and acceptable treatments.

Forage and Water.—Forage and its utilization in relation to water is probably the most important single aspect of multiple use of western wild lands. This is because, first, forage is economically produced and harvested on most of the important water-yielding lands; and second, forage utilization by grazing has probably adversely influenced the usability of water from western watersheds more than any other use. The reasons for the latter are as follows: (*a*) Where forage production prevails as an important use the physiographic balance is often delicate and easily upset by grazing, thereby causing seriours watershed damage; (*b*) the harvest of forage is on an annual basis and often for a considerable period of continuous use each year, thereby subjecting the watershed to frequent and prolonged opportunity for damage; and (*c*) localized misuse of forage and attendant watershed damage occur rather easily, jeopardizing the utility of an entire watershed.

To illustrate the first of these reasons, the vast semidesert areas of the upper Colorado River in Wyoming, Colorado, and Utah may be cited. Here the soil is extremely susceptible to erosion and, although the plant cover is sparse, its grazing value is very essential to the regional economy. With these circumstances grazing is widespread and, unless well managed, it can and does easily cause serious watershed damage. As an illustration of the second reason, any portion of the 728 million acres of western range land can be cited. Almost without exception, grazing animals visit each acre of this land each year. This means that the land is being used almost continuously in terms of an annual harvest and that serious damage is likely if there is the slightest lapse in management practices. The last reason can best be illustrated by the striking example along the Wasatch Front in Utah where denudation of only a few hundred acres by overgrazing on the headwaters of several streams resulted in devastating floods, causing more than $1,000,000 damage during the 10-year period prior to 1934.

In the main, the relation between forage and water is such that proper management for forage yield is also good management for water yield. Under special conditions, however, where the physiographic balance is very delicate, forage utilization may not be compatible with satisfactory water yield, and in these cases total exclusion of grazing is necessary. Generally speaking, forage utilization does not appear to offer as great an opportunity as forest utilization for improving watershed conditions but, over most of the West, grazing is practicable and if properly done causes little watershed damage and may even enhance watershed utility.

Wildlife, Recreation, and Water.—Requirements for production of wildlife and enjoyment of wild-land recreational opportunities are usually in harmony with watershed

management objectives. Recreation and wild-life need a relatively stable, well-regulated supply of clear water and these are usually the exact needs of the water user. Occasionally, localized overpopulation of big game may destroy watershed utility; beaver work may modify the regimen of streamflow; rodents may stir up the soil and add to erosion problems; or man-made watershed improvement devices, such as reservoirs, may conflict with recreational requirements. These are exceptions, however, rather than the rule.

More frequently than not man-made improvements, such as well-planned and operated reservoirs, have enhanced rather than curtailed recreational opportunities, and only in the most unusual cases involving domestic water supply has it been considered necessary to exclude recreational use as a watershed management measure. Land of high recreational value is usually satisfactory watershed land and acceptable dual use, at least, can be realized, as for example the national parks and their highly important and satisfactory contribution to natural streamflow.

As with other multiple uses, recreation and watershed service of land must be co-ordinated and managed intelligently to realize the maximum from each. If this is done there should be little reason to modify the multiple use theory of land management to obtain either of these services.

Adapting Watershed Management to Multiple Land Use.—In spite of the great importance of water yield from western wild-lands, full consideration of watershed management in formulating land-use plans is not always attained. This difficulty commonly arises because some land managers and the public alike may be so strongly impressed with conspicuous local use of timber, grazing, and recreation that these uses are permitted to overshadow the less tangible, but frequently more important, water aspects. Also pressure from local uses oftentimes is more vigorous and vociferous than pressure from more remote water users, who may fail, rather shortsightedly, to appreciate the vital role of multiple-use management on lands at the source of their water supply.

Another reason why watershed management may not be fully appreciated is that use of water from mountain watersheds, in contrast to harvest of timber and forage, seldom brings direct cash income. This makes it difficult to translate watershed management accomplishment into conventional monetary terms and consequently, in the quest for economic justification for all action, water may be foolishly relegated to the background.

These facts mean that managers of mountain watershed lands, in order to safeguard the public interest, must maintain the broadest possible outlook. They must constantly struggle to evaluate and integrate properly all uses and services of the land so that maximum benefits will be derived; and they must particularly avoid permitting any subordinate use, no matter how striking locally, to expand at the expense of broader, more important aspects of land use such as watershed service. These facts mean furthermore that managers of watershed land must acquaint themselves thoroughly with the relationship of water yield to other services and products of the land and, although the water user may be far removed, must bear his interests and needs fully in mind at all times.

It is true that, except for general protection requirements, detailed information on watershed management for most areas has been and still is greatly lacking. In recent years, however, new material has been contributed, and although it is beyond the scope of this paper, there are now many real and practical opportunities for watershed management in the multiple use of wild-lands of the West.—*Journal of Forestry*, Vol. 41, No. 9, dated September, 1943.

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THE LONGEVITY OF PLANTS

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An interesting book recently added to the library of the Botany Branch, Forest Research Institute, Dehra Dun, contains such a wealth of information on the age of plants that it has been thought worthwhile to summarise some of the facts concerning longevity of Phanerogams for those interested in this fascinating subject. Very little information is, however, available in so far as maximum ages, attained by our timber trees, are concerned.

The book referred to above is by Hans Molisch and is entitled *Die Lebensdauer der Pflanze* (1928). English edition translated by E. H. Fulling *The Longevity of Plants* (1938).

Generally speaking the life of a plant may be said to be indefinite; but in nature there are many agencies which shorten the duration of its life. Among these may be mentioned fungus diseases, ravages of vegetable and animal parasites and not the least the hand of man.

Among flowering plants, except in the Monocotyledons, the annual rings provide us with a generally reliable means for determining age, especially when these are sharply differentiated, as for example, in spruce, fir, pine, teak, etc. On the other hand, if the annual rings are narrower and indistinct it becomes extremely difficult even with the help of a microscope to calculate the age with certainty. In addition, many tropical trees of equatorial regions, which live during the entire year under uniform meteorological conditions, show only very indistinct rings or none at all and consequently render the count very difficult or impossible.

In such circumstances it is no wonder that reliable information concerning the age of many trees and shrubs is not available.

Among the longest-lived trees are the coniferous *Sequoias,* characterised by their immense size. They were first discovered in 1850 by the English explorer Lobb on the Sierra Nevada Mountains in California at an altitude of about 1,500 m. There are two species, *S. gigantea* and *S. sempervirens,* both in California where they form entire groves and attain huge dimensions.

Sequoia gigantea (*Sequoiadendron giganteum*) produces trunks which on the average are 83 to 110 m. tall and 3 to 10 m. in diameter. One of these called 'The Father of Woods' was 142m. tall and had a circumference of 36m. at the ground.

In the Berlin Museum there is a stem of a *Sequoia* with a radius of 2,35 m. and 1316 annual rings. As stems of the same tree have been found with a diameter of 15 m. it can be estimated what their age must be. According to Meyer who visited *Sequoias* during his journey through North America some of these trees as old as 4,250 years.

The swamp-cypress, *Taxodium maxicanum* Carr. has long attracted attention by its great length of life. A specimen which Ferdinand Cortez is said to have regarded as one of the greatest wonders of America still stands in the little town of Tule in Mexico. The trunk, measuring more than 31m. in circumference, one and a half meters above ground, supports a widespreading crown 35m. high and so large that its circumference is about 160m. A.P.De Candolle ascribed an age of 6,000 years to this tree and Humboldt attributed 4,000 years to it. Comparative measurements have indicated, however, that it can scarcely be more than 2,000 years old.

The Yew, *Taxus baccata* Linn. is another example of old trees. Some of these trees are

said to have attained an age of 900, 1,225, 2,096, 2,600 and even 3,000 years. According to the elder De Candolle there are Yew trees in England which existed there at the beginning of the Christian era.

The Pyramidal cypress, *Cupressus sempervirens* Linn. is characteristic of the Italian landscape and is native to north Persia and the east Mediterranean region. It grows very slowly, attaining great dimensions and an age of 2,000 to 3,000 years.

The maximum ages of Norway Spruce, *Picea Excelsa* Link. are reported as being 200, 300, 400 and even 1,200 years.

According to various observations *Cedrus libani* Loud. can acquire an age of 1,200 to 1,300 years.

Definite information concerning the age of long-lived Monocotyledons is not available as the stems of these plants do not possess annual rings and we have, consequently, no reliable means of determining their ages. The attempt to decipher their ages by means of leaf scars likewise leads to no practical results.

The Dragon tree, *Dracaena draco* Linn. belongs to the Lily family. It has a tree-like stem, simple or divided at the top and often when old becoming much branched, each branch ending in a crowded head of lance-shaped leaves. The tree derives its name from a resinous exudation known in commerce as dragon's blood. There was once a colossal dragon tree in the town of Orotava in Teneriffe. In 1799 it had a circumference of about 15m. and a height of 22m. The tree was hollow and could be ascended by a staircase in the interior up to the height it began to branch. Unfortunately it was totally destroyed by a hurricane in 1868. On the basis of historical facts and the idea that this tree grows very slowly Humboldt estimated it to be 6,000 years of age. That was merely an estimate, however, for the dragon tree is a Monocotyledonous plant whose age cannot be determined with certainty as it possesses no annual rings. According to Putter the dragon tree cannot survive more than 200 years.

The stately proportions which palms can acquire leads one to conclude that they are able to attain great age. The Wax palm, *Ceroxylon andicolum* which grows in the Andes and which was studied by Humboldt exhibited heights of 52 to 60m. Concerning its age, however, information is not available.

Longevity is a characteristic of all species of oak, but the English oak, *Quercus pedunculata* Ehr. is celebrated above all others for the great age to which it attains. In many districts of England, there exist huge living remains of giant oaks, whose age cannot be calculated with accuracy, but on comparison with younger trees authentically known to be 300 to 400 years old, they may be reckoned to have stood for more than a thousand years.

According to Willkomm the walnut, *Juglans regia* Linn. can attain an age of 300 to 400 years.

According to various descriptions by travellers and others it is certain that in the tropics, the various arborescent species of fig can reach great age. The sacred Bo tree, *Ficus religiosa* of Anuradhapura in Ceylon is said to have been planted by Mehinda in 307 B.C. Another account says that it was planted in the 18th year of the reign of King Deveniplatissa, or 288 B.C. and must accordingly, have attained an age of over twenty centuries. The tree is held in veneration and kings dedicate their possessions to it in the thought that beneath it Buddha rested at the time of his apotheosis. The tree has been revered for 2,000 years and, since this reverence has never ceased but extraordinary care has been accorded it, it is regarded as unlikely that the original tree has ever died and been replaced by another.

The Baobab or Monkey-bread tree, *Adansonia digitata* Linn. is a native of many parts of Africa and is now commonly cultivated in this country. It has been called 'the tree of thousand years'. Humbodt speaks of it as 'the oldest organic monument of our planet.' Adanson whose name the genus bears, travelled in Senegal in 1794, where he found this tree. His calculation shows that one of them,

measuring 10m. in diameter must be 5,150 years old. On several large trunks Adanson observed that the names of French and Dutch sailors had been inscribed. One of these was dated the 14th, the other in the 15th century.

Perhaps the most famous of European trees is the Lime. *Tilia.* The age of some of these has been reckoned at 700 to 800 years.

The Grape-vine. *Vitis vinifera* Linn. is said to attain an age of 80 to 100 years.

Though the upper shoots of the rose do not become old the entire plant can, nevertheless, attain considerable age for it continually grows by stem and root shoots.

According to Kanngeisser the famous rose tree at the dome of Hildesheim in Germany might be at least 400 years of age.

Robinia pseudoacacia Linn. can become more than 200 years old and *Wistaria sinensis* Sweet can attain an age of 50 to 60 years.

Numerous examples of very old English Ivy, *Hedera helix* Linn. are on record. An age of 200 to 400 years having been ascribed to several of them.

On Mount Olivet in Jerusalem Olive trees, *Olea europea* Linn. can be seen which are considered to be the same which existed there at the commencement of the Christian era.

The Ash, *Fraxinus excelsior* Linn. attains considerable age. Very old trees are estimated to be 200 to 250 years of age.

According to the *Times of India* dated the 7th May 1936 'Queensland claims to have the oldest living thing on earth. It is a *Macrozamia*, a tree about 20 ft. in height and estimated to be more than 12,000 years old. In the Tamborina mountain reserve there is a whole grove of *Macrozamia,* the youngest of them being 3 ft. in height and 3,000 years old. When Prof. Chamberlain of the Chicago University was appointed to collect data concerning *Macrozamias* in various parts of the world, he travelled all over the globe and the largest specimen he had seen prior coming to Queensland was between 6-7 ft. in height. He was amazed, therefore, when he found in the Tamborina reserve a whole grove of *Macrozamia* which measured over 20 ft. in height and whose age he estimated to be between 12,000 to 1500 years.'

The following table gives a review of the maximum ages observed among Phanerogams, a few of which have already been dealt with in this paper. The succession in the table is such that, irrespective of their phylogeny, those are first listed which are distinguished by the greatest longevities, followed by those of shorter life and finally the short lived. It must also be noted that the ages given are only approximate for the longevity of any species varies within certain limits and the figures given are often based only on estimates.

Review of the maximum periods of longevity of Phanerogams.

Name	Maximum age.	Circumference in meters.	Diameter.	Height in meters.
Macrozamia sp. ..	12,000—15,000(?) ..	..	..	..
Adansonia digitata ..	5,150 ..	..	..	10
Sequoia ..	4,000—5,000 ..	..	10 m.	142
Ficus religiosa ..	2,000—3,000(?) ..	..	..	..
Cupressus sempervirens ..	2,000—3,000 ..	..	3 m.	50
Taxus baccata ..	900—3,000 ..	..	..	..
Juniperus communis ..	2,000 ..	2.75	..	..
Taxodium distichum ..	2,000 ..	..	..	..
Cedrus libani ..	1,200—1,300 ..	..	..	..
Picea excelsa ..	200—1,200 ..	..	..	..
Tilia sp. ..	800—1,000 ..	16.5	4.5 m.	..
Quercus sp. ..	500—1,000 ..	..	..	..
Fagus sylvatica ..	600—930 ..	..	..	..
Dammara (Agathis) austrlis ..	700—800 ..	..	..	..
Castanea vulgaris ..	500—700 ..	9	..	..

Name		Maximum age.		Circumference in meters.	Diameter.	Height in meters.
Olea europea	..	700	..	6.4	..	..
Ulmus sp.	..	300—600	..	16.68	..	36
Juglans regia	..	300—400	..	..	..	..
Fraxinus excelsior	..	250	..	..	..	..
Dracœna Draco	..	185—200	..	17.45	4.82 m.	22
Acer oampestre	..	150—200	..	3.4	..	..
Pyrus malus	..	200	..	3.63	..	..
Robinia pseudoacacia	..	200	..	..	..	..
Hedera helix	..	200	..	..	..	..
Myrtus communis	..	156	..	..	..	..
Salix alba	..	150	..	7	..	..
Buxus sempervirens	..	150	..	..	..	..
Corylus colurna	..	100	..	..	..	..
Rhamnus cathartica	..	100	..	..	..	..
Vitis vinifera	..	80—100	..	..	..	..
Sambucus nigra	..	100	..	..	..	..
Sorbus aucuparia	..	80	..	..	..	..
Wistaria sinenses	..	60	..	..	..	..
Rhododendron ferrugineum	..	40	..	..	..	..
Elaegnus angustifolia	..	33	..	..	..	..
Cytissus loburnum	..	30	..	..	..	..
Berberis vulgaris	..	24	..	..	..	..
Ligustrum vulgare	..	23	..	..	4.5 cm.	..

INSIDE THE TIGER

By J. N. Sinha, Divisional Forest Officer

"Is the cycle in order?"

"Yes Sir; so far as the going goes it will go."

"How do you mean, so far as the going goes. . . .?"

"There is no brake."

I had just started my career in the Forest Department. I am not sure how homesick Ramchandra had felt after his fourteen years' exile in the forest, but in my case twenty days or a month in those lonely wilds was enough to churn the heart with longing for home. How eagerly would I be counting the days of return from camp! In such forests sages have sat in contemplation and found God. In this silent sylvan solitude, they say, the mind finds peace. Maybe. But so far as I was concerned, after a fortnight's forest camp my soul found peace in the tumult of the railway platform. The raucous shrieks of the vendor sounded musical. The engine's hoot descended upon the heart like the langorous coo of the cuckoo, and the trailing curls of smoke behind the running train looked like the flowing locks of a playful maiden. The fact is that inside the forest Nature appears to be assimilating us, to be taking us back from whatever we know good and live for. The chin may turn into thicket, but the urge to shave is gone. The feelings are those of the lovely deserted woman—'for whom shall I decorate?'

It was winter. The cold was bitter and intense. To-day I got up earlier than usual for I had to return to headquarters. The railway station was eleven miles away from camp and the train was due at 9 a.m. While it was still dark I marched off the coolies with the kit and orderly. I had borrowed a bicycle. I could start later.

Between my camp and the station stood a solid continuous phalanx of forest. To the perspiring pedestrian or the whining cyclist, the entire world looked transformed at once into one series of hills and forests. The sun had risen but its rays had not yet reached these guarded caves of foliage. After a while on the peak to the west the shy sunshine hesitatingly alighted. Slowly, circumspectly, it crept down the hillside, conquering by its charm all that it touched. But when it met the floor of the forest it broke to bits. There it lay in pieces, clinging to the clumps of shadow, as if fearful of being there alone. This shadow-and-light produced an air of illusion, and that which was real looked unreal that which was unreal true.

I was careering along, on my borrowed cycle. To the youthful vigour and dash was added the tonic urge of a journey home. The muscles made short work of the upgrades, but on the downward slopes the brakeless cycle made me powerless. The outstretched legs caught the front wheel in pincers and thus the mad gallop would be tamed a bit. At a distance of about five miles from camp, I overtook the coolies and bidding them speed on, I went forward.

A mile onward came a long descent. On the right, the hill rose like a wall, while on the left was a sheer precipice. As I turned a corner an obstacle in half shadow half light came to view. What could it be, I thought. Might it be a boulder which had rolled down the hillside, or perhaps a dead dry log? I pressed hard my "feet" brake. By this time the cycle had approached quite close to the object. A movement was noticed in the object. The cycle approached closer still. O God, what do I see in front but a huge tiger sprawling across the road almost blocking it! His head was towards the hill, the tail towards the precipice. When he saw me and my cycle rushing headlong at him, he slowly turned his head towards me with a look that was the complex of indifference, annoyance and curiosity. Death stared me in the face. My problem now, seeing that the cycle would not

stop, was which way to get past the tiger. I had not yet decided when helplessly I found myself almost upon the tiger. Sheer instinct now came to my aid and the cycle turned towards the tail. When my cycle touched the tiger's tail he turned right about in a flash and his head grazed my body. By now I had lost consciousness. Nor was I entirely unconscious, for it came upon me that the tiger had caught my head in his wide mouth and with his paws on the luggage carrier was trailing behind the cycle. There was a background to this obsession. In the bad tiger parts of Orissa forests a forest guard had once been lifted away by a man-eating tiger right in front of my eyes.

The cycle meanwhile rolled on and on. Finally having reached the limits of the down slope it fell. And with it I fell too. There I lay for how long I do not know. And in that peculiar unconscious-conscious state, the obsession persisted that the tiger had swallowed me. I am inside the tiger, I was thinking. Oh, what an end, what an end! After what seemed to be an eternity the eyes diffidently opened. I saw the cycle. What? Is the cycle also inside the tiger's stomach? Has the tiger eaten up the cycle too? The eyes rose upwards. I saw the trees. I rubbed my eyes, and looked about. Oh, I am alive. I am not inside the tiger. But my reverie was soon broken for the tiger was slowly coming down the road towards me. O God, I am not yet saved. And I jumped up and ran in terror. But soon I was tired and panting and things looked dark and hopeless. Suddenly I found myself up a *semul* tree. At last I was safe. I felt relieved. By this time the tiger had approached the cycle. He smelt it, then scratched and pulled at it wondering if this was the miserable assailant that had rushed headlong towards him. Finally he gave the cycle a kick of annoyance and walked up the road towards me. Fortunately he had not seen me climb the tree for he went past below without stopping or looking up. When he disappeared round the corner I got back my life and I thanked God. All this time my eyes had been riveted to the tiger. Now they were free to look about. But what was it that I saw on looking at my body? The shirt was red and reeking with blood. The shorts and the hose too were wet and red. The sight of blood brought back the obsession—the tiger has eaten me up, I am inside the tiger. Persistently I argued with myself that I was alive and sitting in the tree, that my own eyes had seen the tiger disappear. Persistently, however, the obsession returned and overpowered me. And I sat in that peculiar unconscious-conscious belief grieving that I had ended inside the tiger.

After some time, which again seemed to be an age, human voice brought me back to consciousness. My coolies were coming. I saw them and felt the urge to shout and inform them that I was there. But my voice utterly failed me. When they saw the tiger's pug mark they shouted, *Kula manda, Kula manda.** On discovering that the pug marks were superimposed on the cycle track, they concluded that the tiger had chased the *sahib*. Soon in the *nala* bed they saw the cycle lying but neither the *sahib* nor the tiger. That could mean nothing else except that the tiger had at this point caught hold of the *sahib* and carried him away. The coolies dropped their load and sank in sorrow. I tried again to shout and tell them that I was there and alive, but in vain. Helplessly I sat there, a witness to the grief over my own death. My orderly, however, was more intelligent than the coolies. He continued the investigation. He knew my hobnailed boots which he used to polish every morning. He noticed that the marks of my boots had gone further than the cycle and pointed this out to the others. Death turned into life in a flash and the coolies leapt in joy shouting, *gomke niriyana, gomke niriyana.** They followed the boot-prints. Soon, however, they discovered that the tiger's pug marks had also continued. Was the tiger still chasing their *sahib*? Under the tree the

*In the Ho language "Kula" means tiger, "manda" pugmark and "gomke niriyana" means "saheb has fled".

boot-prints vanished while the pug marks continued. Clearly here the tiger had overtaken the *sahib* and carried him away. Now the simple Ho folk completely broke down in grief. But even now I could not find speech. After a while one of the coolies casually looked up. Our eyes met and we both mutely smiled. . . . .

While trying to get down, the blood in my clothes explained itself. The trunk of the young *semul* tree was thickly studded with long sturdy thorns, and it was by pressing my breast and legs hard against these very thorns that I had climbed up. The thorns had pierced my body all over like a thousand needles and blood was emerging from a thousand points. Seeing my helpless plight my orderly threw up his *pugree* and tying one end of it to a branch, I somehow descended.

When I returned to headquarters, I wrote to my people describing the incident. By the third day, my wife had arrived and did not rest until I had signed my resignation letter. Where was the sense in continuing in a service where one could be devoured by tiger any day? We started packing.

A fortnight later, while trying to clear a heap of pending papers, I discovered that the resignation letter instead of being posted had been lying on my table. I read it again. My eyes wandered and fell on the last census report peeping out of the corner of the dusty book-shelf. I opened the chapter on "death by wild animals" and found it recorded that no forest officer had met such an end.

I tore off the resignation letter.

CONVOCATION OF THE INDIAN FOREST COLLEGE AND THE INDIAN FOREST RANGER COLLEGE, DEHRA DUN

The third convocation of the Indian Forest College, marking the ceremonial close of the third biennial course, and the convocation of the Indian Forest Ranger College, now an annual feature, since the reintroduction of an annual intake and overlapping classes, were held together in the convocation hall of the Forest Research Institute, New Forest, Dehra Dun, at 11 a.m. on Saturday April 1st, 1944. The hall, which has been handed over for use by military hospital authorities, was kindly vacated for the purpose, and despite the difficulties of transport in war-time, a very large gathering of several hundred people assembled, including many distinguished visitors, the staffs of the Forest Research Institute and the two colleges, and about 160 students of both colleges.

The Honourable Sir Jogendra Singh, Member of H. E. the Viceroy's Executive Council, in charge of the Department of Education, Health and Lands, came from Delhi to Dehra Dun, accompanied by Lady Singh, especially to attend the convocation and to present the diplomas, certificates and prizes.

The proceedings were opened by Sir Herbert Howard, Inspector-General of Forests and President, Forest Research Institute and Colleges, who welcomed Sir Jogendra Singh and then addressed a few words to the outgoing students of both colleges. He then called on the Principal, Indian Forest College, Mr. E. C. Mobbs, and the Director, Indian Forest Ranger College, Mr. C. R. Ranganathan, to present their reports. After these reports had been given, he then called on Sir Jogendra Singh to address the gathering.

Before distributing the diplomas, certificates and prizes, Sir Jogenrda Singh was asked to bestow the badge and *sanad* of Rai Sahib on Mr. Ganga Singh, one of the Forest Research Institute artists. He then presented the diplomas and prizes to the outgoing students of the Indian Forest College, which was followed by the presentation of the certificates and prizes to the outgoing students of the Indian Forest Ranger College. The very impressive and memorable joint convocation of the two colleges ended with three rousing cheers for Sir Jogendra Singh, led by Ram Chandra

Kaushik, the student standing first in the Indian Forest College.

In welcoming Sir Jogendra Singh, Sir Herbert Howard, Inspector-General of Forests and President, Forest Research Institute and Colleges, said:

"Sir Jogendra Singh, Principal of the Indian Forest College, Director of the Indian Forest Ranger College, ladies and gentlemen,—

On behalf of all of us I should like to welcome to-day the Hon'ble Member for the Department of Education, Health and Lands, Sir Jogendra Singh, who has kindly consented to preside at this convocation. Sir Jogendra Singh is an agriculturist and is therefore doubly welcome to us forest officers. In a country such as India the planning of agriculture must go hand in hand with the planning of forestry. Because that fact has not always been sufficiently recognised in the past, India to-day suffers so greatly from poverty and insufficient production of food for its many millions of inhabitants. I also wish to welcome those new students who are present here among us for the first time.

Since last convocation the hospital has moved into a large part of this building lent to them for the sick and wounded. This particular room was lent as a ward for 100 beds. I am sure we are all happy to know that so far it has not had to be used for that so that Col. Dickie was able to let us use it to-day for convocation as usual.

People do not come to this convocation to hear me make a speech and it is my custom to leave the gentleman presiding to give any advice to departing students that he may deem fit. But as I am now at the end of my service, I may perhaps be permitted to say something to the students.

I want first to address more particularly you Ranger students who are leaving us to start your profession. The object of your college is to give you the finest training that it is possible to give to you. On paper the similarity of forest courses is more apparent sometimes than their differences. You Rangers may yourselves have felt that your training was similar to that of the gazetted officer. But I want to dwell, not on the similarity of the training to that of the gazetted officer but on the difference. You will be judged on your capabilities as Rangers. If the forest service wanted eight divisional officers in a division, it would train eight divisional officers and there would be no need to have two different courses here. But what it wants is one divisional officer and seven rangers and unless these colleges manage to produce that—then the colleges have failed. You Rangers have often been called, and rightly called, the backbone of the service. You *are* the backbone of the service. Without you the whole body of foresters would be a limp and spineless thing—but remember that a backbone without a head is nothing but a dead body. The forest service cannot be regarded as a set of separate compartments. Each part of the service is complementary to each other part. Besides the many silvicultural works—you Rangers are the men who actually have to do the burning of firelines, control burning, the burning of slash and so on, and a mistake in your judgment can cause thousands of rupees worth of damage.

It is you who actually have to do road repairs, building and bridge construction, align roads in dense jungle, put up various types of fences, bale hay in fodder famines and keep the presses in order. All these things are easy in theory but enormously difficult in practice and it is a skill which cannot be learnt in the lecture room.

You Rangers may perhaps be likened to the craftsmen of the forest service—the men who, by their detailed technical skill in the various practical forest operations, turn the designer's plan into a finished and artistic whole. Without you—with poor craftsmen however good the plan, the forest will not attain that full production of increment from the soil at which we aim. I want you to be proud of that particular function of yours, which turns the chaos of a virgin forest into that ordered beauty which is the forester's ideal. Do not expect that your divisional

officers will have your particular craftsmen's skill,—that is your speciality.

And to you young gazetted officers, your college also tries to give the highest training for your particular function as divisional forest officers. The worth of a forest service is eventually dependent on the standard of its divisional forest officers. Conservators and chief conservators have their parts to play. But while a set of good divisional forest officers can carry a bad conservator for a considerable time, even a good conservator is helpless with a set of bad divisional forest officers. You will have to plan the designs of forestry and see them carried out, but to you I say be humble and modest. When you leave this college, you will, I hope, have a good knowledge of the theory of forestry, but you will know little or nothing of its practical application. The first thing you have to do is to learn how to translate your theoretical knowledge into the practical art of forestry. Remember always that your ranger in certain matters is better than you are—that is after all what he has been trained for. Try and learn something of his particular form of craftsmanship. It would be a good thing for all of you if you could be made range officers for a year after you leave here. In war-time that will probably not be possible. But still, learn all you can of the ranger's work. When he realises that you both understand and appreciate the difficulties of his task, only then will you gain his respect. Nobody is quicker than a ranger at knowing when a divisional officer's order cannot be carried out in practice or can only be carried out partially and with very great difficulty. But believe me, once the ranger realises that you understand his problems as well as your own, then there is no body of men from whom you will get more help or from whom you will get more loyal service. You cannot do your job without the ranger's help and your success or failure will partly depend on what your rangers do for you.

And now to both of you. I would say discuss all your problems in as great detail as you can with all those likely to be affected by your decisions and remember that among those people are included the villagers. Hear what they all have to say. But there will come a time when you have listened to all sides and have finally decided on your plan of action. When that stage comes, stop discussion and get on with the job. If you continue discussions interminably, you will merely get the reputation of an officer who cannot make up his own mind and cannot make decisions—and that is the worst reputation that you can get. I will go further and say that at the stage of action do the job even if you do it wrongly. Better to do it wrongly than to go on talking. You will learn by your mistakes.

I want you both to realise that what you are doing has a very direct bearing on the war itself. I do not mean from the research point of view. What this Institute has been doing in direct furtherance of the war is partly told in reports and bulletins but it is a story which cannot be fully written till the war ends and, from what I know, I can say that it will have no need to be ashamed of its record. But you people will not be concerned at first with research. You will be concerned with the direct and necessary supplies of timber to the armies who are fighting this war. Timber in modern war is an absolute essential and without it the war would cease by the defeat of those who lacked it. Timber, simply as timber, is being used for railway sleepers, telegraph poles, hutting timber, bridge timber, jetty piles, boats, barges, lorry bodies, in aircraft construction, for air screws, for aeroplane hangars, and in fact it comes in somewhere at almost every stage. Apart from civilian demands, the forest services of India are supplying to the army something like a million tons of timber a year, or, at any rate, that is the last figure I have. To visualise a million tons is difficult but, as I have said elsewhere, placed end to end, it would make a track some 10 ft. wide round the world at the equator.

Before I end there is one small professional matter which I want to bring to your notice. You have a monthly journal—the *Indian*

Forester—which has been in existence since 1875. Write for it. It cannot exist otherwise. And buy it. The subscriptions have so decreased during the war that last year (1943) the Journal was barely self-supporting and encroachment on capital was narrowly avoided. With your training as foresters in the principle of sustained yield, I do not need to remind you of the result of depleting capital."

After extending a welcome to Sir Jogendra Singh on behalf of the staff and students of the Indian Forest College, the Principal, Mr. E. C. Mobbs, I.F.S., presented his report as follows:

Report of the Principal, Indian Forest College on the 1942—44 Course

The Indian Forest College has reached today the third milestone in its career. The milestones are fairly far apart, for to-day we also celebrate our 6th birthday, each mile representing two years' solid work in the training of men for the gazetted forest services of the various Provinces and States of India.

Compared with our sister institution, the Indian Forest Ranger College, with whom we for the first time have the pleasure of holding a joint convocation, we have perhaps not progressed very far. But as the journey has lengthened, the work of the College has steadily expanded, and it may now be considered well established in its career.

The College has only a single class; the course extends over two years, and each class completes its course before a new one is admitted. It started its career with 16 students in the 1938—40 class. This was expanded to 21 students for the second class, 1940—42; while the third class, 1942—44, which is passing out to-day, comprises 30 students. Of these, 28 have attended the full course, while two were admitted for the second year of the course only, after having taken the full course of the Indian Forest Ranger College. The 28 comprise 20 from Provinces and 8 from States, while the additional two are both from States. The Provinces represented are Assam, Bengal, Bombay, Central Provinces, Orissa, Punjab and the United Provinces. There are no students in this class from Bihar, Madras or Sind. The States represented are Baroda, Gwalior, Hyderabad, Indore, Jubbal, Kashmir and Mysore.

In my report at the last convocation of the College in 1942, I referred to the expansion of the College accommodation to meet the needs of the growing classes, and I expressed the opinion that the College was fortunate in its excellent accommodation in this fine Forest Research Institute building. Since then, however, in common with all the other branches of the institute, we have given up a good part of our accommodation to the hospital now established here. This has meant the loss of our new students' common room, two office rooms, a large store-room and a museum gallery. To fit into the space left to us, we have had to give up our new drawing hall, which has been converted into offices, store-room and common-room, while our collections of entomological and geological specimens have been housed elsewhere in the institute building, where they are not easily available to students. The biological laboratory has now to serve also as a drawing hall. Though these changes have undoubtedly cramped us, we are still able to carry on, and we cheerfully accept the inconveniences as necessary during the war.

Owing to the expansion of the College, and to relieve the Forest Botanist of some of the lecturing in Botany, the staff has been increased by an additional lecturer. Mr. B. S. Chengapa, formerly Assistant to the Chief Forest Officer of the Andamans, joined the College as lecturer for the first year of the course. On his appointment as Assistant Utilisation Officer in the Forest Research Institute, his place was taken by Mr. S. Ramaswami, formerly Assistant Minor Forest Products Officer.

For the rest, the staff of the College, consisting of the Pirncipal, and the Lecturer in Surveying and Engineering, Mr. J. L. Harrison, I.F.S., has remained unchanged, while the various research officers of the Forest

Research Institute have again conducted the courses in their respective subjects, namely:

In the **Botanical Branch.**—Dr. K. D. Bagchee, M.Sc., D.Sc., D.I.C., F.N.I., Forest Botanist, and Mr. M. B. Raizada, M.Sc., Assistant Botanist.

In the **Entomological Branch.**—Mr. J. C. M. Gardner, A.R.C.S., D.I.C., F.R.E.S., I.F.S., Forest Entomologist, and Dr. N. C. Chatterjee, D.Sc., Assistant Entomologist.

In the **Utilisation Branch.**—Mr. E. L. P. Foster, B.A., O.B.E., I.F.S., Utilization Officer, Mr. M. P. Bhargava, M.Sc., A.I.C., Paper Pulp Officer, Mr. Chatter Singh, B.A., Assistant Paper Pulp Officer, Dr. K. A. Chowdhury, B.A., D.Sc., M.S., Wood Technologist, Mr. V. D. Limaye, B.E., Timber Testing Officer, Dr. D. Narayanamurti, M.Sc., A.I.I.Sc., A.I.C., Dr. Ing., F.N.I., Wood Preservation Officer, Mr. M. A. Rehman, M.Sc., Wood Seasoning Officer, Mr. Sultan Mohd., Asstt. Wood Workshop Officer.

In the **Chemical Branch.**—Dr. S. Krishna, Ph.D., D.Sc., C.I.E., Bio-Chemist, and and the Soil Chemist Dr. R. S. Gupta, M.Sc., Ph.D.

In the **Silviculture Branch.**—Mr. A. L. Griffith, M.A., M.Sc., I.F.S., Silviculturist, Mr Jagdamba Prasad, B.Sc., LL.B., Experimental Assistant Silviculturist, Mr. Sant Ram, Statistical Assistant Silviculturist; Mr. E. Joseph, Forest Ranger.

In addition, Dr. A. G. Jhingran, M.Sc., Ph.D., Geologist, was again deputed by the Director, Geological Survey of India, to give a short course in Geology.

To all these officers the College again tenders its grateful thanks.

The course, which has now become more or less standardised, has included all the subjects which I have detailed in previous reports, namely: Forestry proper, including Silviculture, Mensuration, Management, Valuation and Protection, and the preparation of a Working Plan, Forest Botany and Ecology, Forest Zoology, Geology and Soil Science, Surveying, Engineering, Utilisation and Forest Law.

Practical work and tours have again occupied nearly one half of the available time. The practical work has included thinnings, nursery work and plantation work in the New Forest Estate, and cleanings, thinnings and markings for fellings on tour. It has also again included an excellent course on practical field engineering with King George V's Own Bengal Sappers and Miners at Roorkee. We are very grateful to the Commandant and his officers for again arranging this course, despite the great increase in their own training work for the war.

Touring in war-time has many attendant difficulties, and we have had necessarily somewhat to restrict the tours. Various forests visited by previous classes had to be excluded from our programmes, notably—Buxa division in Bengal, the three Kanara divisions of Bombay, and Madura and North Salem Divisions of Madras.

At the same time, the study in the field of as many different types of forest and as great a variety of silvicultural treatment and methods of management as possible forms such an important and such a broadening part of the training of forest officers, that every endeavour has been made to make the tours as wide and as representative as present conditions would allow.

During the first year the class toured in the Himalayan forests of Chakrata division in the U.P. and Darjeeling division in Bengal; the sal and miscellaneous forests of Kurseong division in Bengal and Gorakhpur, Haldwani, Ramnagar, Dehra Dun and Saharanpur divisions in the U.P.; the erosion areas of Hoshiarpur division and the Pabbi Hills, and the bamboo forests of Beas division in the Punjab.

The second year included a tour in the Kulu division of the Punjab, and a South and Central India tour to Coorg, Madras and the C.P. In Madras the Wynaad, Nilambur, Nilgiris and North Coimbatore divisions were visited, and in the C. P. Betul division.

On all the tours special attention was paid not only to past and current practice, but to experimental work under Provincial Silviculturists, to the village work of the Forest Development Officer in the U.P., and to village work under the Divisional Forest Officers and the Soil Conservation Officers in the Punjab.

The tours have, as usual, included the study of various engineering works, such as wire ropeways, wet slides and forest tramways, besides roads, bridges and buildings. A number of forest saw-mills and depots were visited and instruction given by Timber Supply Officers and others on timber supply for defence purposes. Large commercial saw-mills, *katha*, resin, bobbin, match, furniture and other factories were also visited.

None of the tours would have been possible without the co-operation of the local forest officers and of the railways and other transport authorities. We are extremely grateful to them all, and especially to the Divisional Forest Officers, the Rangers and their staffs of the divisions visited, and to the Divisional Superintendent of the East Indian Railway at Moradabad, for their assistance so generously given.

The war has also increased the difficulties in the domestic side of the college. Every effort has been made to maintain the standard of the common mess, which is now run by the students themselves, instead of through a contractor, but economies have had necessarily to be introduced, among them a great reduction in the number of mess guest nights. Despite the economies, the students are finding it increasingly difficult to live on their stipends. In some respects economies are not possible—they must have books and paper, drawing instruments and the like for their work, and they must have boots, clothes and equipment for a strenuous life on tour, as well as for use at the College and for games,—and I consider that any further economy in the standard of feeding would react unfavourably on the general health and standard of work. Some Provinces and States have granted increases in stipend, but for the rest, especially those who grant no stipend at all, their students are finding it most difficult to make both ends meet. From the point of view of the College, it would certainly be better if all students could receive the same treatment in respect of stipend and dearness allowances.

The general health of the students has been good; although there have been minor cases of sickness, chiefly malaria and infection from tick and other bites on tour.

In games, the policy of requiring all students to practise all games has been continued, special attention being paid to tennis, which, under the careful management of our tennis secretary, Mr. Swamy, we have managed to play throughout the course. The Open Championship Cup for tennis has been won by Mr. Swamy, of Mysore, while the Principal's Cup for beginners was won by Mr. Sharma of C. P.

In other games, the class has done creditably. In the first year the College team won the Beeson Football Cup in the annual tournaments between the two colleges and the Forest Research Institute, and in the annual sports the College won the Athletic Cup, the Individual Championship Cup going to Bachan Singh of this College. In the second year, we unfortunately lost the football cup in the last five minutes of our last match, after a most exciting game, but we have retained the Athletic Cup, Bachan Singh again winning the championship.

Through the kindness of the Commandant of the Indian Military Academy, all students underwent a course of Physical Training, and some of them a riding course, conducted by the I. M. A. staff. This, together with the games and the strenuous exercise on tour, has resulted in a marked improvement in the general physique of the class. That the general standard is good was shown on the Kulu tour last June, when all students climbed to over 13,000 feet on routine excursions, while on one off day 15 of them climbed a peak over 15,000 feet high.

Nevertheless, so far as games are concerned, I feel that the general proficiency in and enthusiasm for athletics of all kinds leaves something to be desired. I am told that with the high educational qualifications we demand, we are not likely to get many good athletes, as in the honours science degree

classes at the universities, the evenings have to be spent in the laboratories instead of on the playing fields. That we do get some students who combine both athletic prowess and the scholarship we require shows that these need not necessarily be divorced from each other, and I would again like to emphasise the importance of Provinces and States selecting as their candidates men with an aptitude for games as well as with high educational qualifications. Among students proficiency at games is usually a good indication of physical fitness, and is perhaps as valuable as, if not better than, a single physical test at the time of selection; while the athletic type of man is perhaps more likely to succeed later on in the strenuous life of a forest officer.

Before passing to the results of the 1942-44 course, there are a few special points to which I should like to refer.

Firstly, I am happy to be able to report that the Indian part of the Currie Scholarship has again been awarded to past students of this College. The amount of the prizes for 1941 and 1942 was distributed in the ratio of 60 and 40 percent to the two students standing first and second in the 1940—42 class.

The awards were therefore:—

1st Prize (£45—approximately Rs. 600) to Kailash Chandra Jain, M.Sc., A.I.F.C., (Honours Diploma, Indian Forest College), United Provinces.

2nd Prize (£30—approximately Rs. 400) to Mohan Lal Mehta, M.Sc., A.I.F.C. (Diploma, Indian Forest College), Kashmir.

Next I may mention the revision of the College Rules. The original rules were simply a copy of the old rules of the Indian Forest Service College, during its short life from 1926 to 1932. Various deviations had to be made from them and new rules were, therefore, submitted to the Board of Forestry at its meeting in November 1942, and after the Board's approval, they have now received the official sanction of the Govt. of India. Among the modifications introduced, the more important are the raising of the age limit by one year—students must now be under the age of 24 on admission to the College,—the widening of the educational qualifications, and the introduction of definite rules for the admission of rangers. Under the old rules candidates had to possess an honours science degree not lower than 2nd class in Chemistry, Botany or Zoology. This has now been broadened to admit an honours degree not lower than 2nd class in any science, mathematics or agriculture. Further, since an Agricultural training has been found to be a very good preliminary to Forestry, a pass degree in Agriculture may be admitted if a first class.

In his address at the last Convocation of the College, the Inspector-General of Forests, Sir Herbert Howard, mentioned that he was frequently asked both by Provinces and States to accept a lower qualification for some individual than that laid down. He pointed out that although he usually did waive the rules wherever possible, as it is our business to train the men whom the Provinces and States want, this was not desirable; experience showed that students not properly qualified find it difficult to follow the course, and they impede the general progress. This has again been the experience in the present class. There may be exceptions, we have some in the present class, when the waiving of the rules for special cases may be fully justified by the results attained, but in general, those who are not fully qualified find it difficult to keep up with the course, and they tend to impede the progress of the class.

The inclusion in the rules of the provisions for the admission of Rangers, for whom a higher age limit has been fixed, is important. Rangers may be admitted for the full course, or if they hold the honours certificate of the Ranger College, and possess the other qualifications required, they may be admitted for the second year of the course only. One Ranger student, after completing the course at the Indian Forest Ranger College, where he stood 1st, was admitted for the second year of the 1940—42 course, and secured the College diploma. In the present class two of the students taking the full course had previously

taken the certificate of the Madras Forest College at Coimbatore, and had served as rangers in their Province, while one of the two who joined the course for the second year only had also served as a ranger in his State after passing out of the Ranger College here.

No one could be in greater sympathy than myself with the policy of giving every opportunity to promising young rangers to aspire to higher service, and I should at all times gladly welcome such men to this College. It is my duty, however, to point out that such men should be carefully selected if they are to make good compared with the younger and perhaps more highly qualified men who come here straight from their universities.

I am pleased to be able to report that the three rangers who joined the present course, two for the full course and one for the second year, and the fourth man who joined us direct from the Ranger College, have all obtained the pass diploma of the College, their positions being 5th, 6th, 13th and 17th respectively.

In connection with the revision of the College Rules, an important event has been the official recognition of the Diploma of the College as a post-graduate diploma, in the grant by the Government of India of the Associateship of the College to Diploma holders with the right to use the letters A.I.F.C. after their names. This brings the College and its Diploma into line with other institutions, such as the Indian School of Mines, where a post-graduate diploma receives similar recognition.

A matter on which I may perhaps be permitted to express an opinion, after having served as Principal of the College since its inception 6 years ago, is the question of the duration of the course. Our course lasts two years but this is really too short a time in which to teach all that should be taught here in the great variety of subjects that have to be studied. The students have a very full programme and do not get that amount of leisure for general reading and study that ought to be theirs if they are to take full advantage of all the facilities that this Research Institute has to offer. I feel, and I know that there are many who feel with me, that the course should be of 3 years' duration. This would mean having overlapping classes, with increased accommodation and increased staff, and of course it would add to the cost of training, but given the accommodation and staff, it would not be difficult to arrange, and I feel that the ultimate good would be well worth the additional expenditure involved.

Turning now to the results of the 1942-44 class. I should like first of all to thank the various officers who have acted as examiners for the College. For the final examinations we are indebted to Sir Harold Glover, formerly Chief Conservator of Forests of the Punjab, for acting as examiner in Silviculture and General Protection, to Mr. Raynor, Conservator of Forests, Working Plans and Research Circle, U. P., for examining in Forest Management, and to Mr. Duncan, Deputy Conservator of Forests (formerly Forest Engineer), U. P., for again examining in Engineering. Among the Forest Research Institute staff, we are indebted also to Mr. Gardner, Forest Entomologist, and Mr. Khan, Systematic Entomologist, for examining in Forest Zoology; Dr. Bagchee, Forest Botanist, and Mr. Raizada, Systematic Botanist, for examining in Botany; Mr. Foster, Utilisation Officer, and Dr. Chowdhury, Wood Technologist, for examining in Utilisation; and Mr. Jagdamba Prasad, Experimental Assistant Silviculturist, for examining in Forest Law.

The results are based on the first year and final examinations and also on the record of students throughout the whole course, marks being allotted for work on tours, for botanical and entomological collections, for plates drawn in Surveying and Engineering, and for general considerations.

Two Diplomas are awarded—the Honours and the Pass. In the present class one student has secured the Honours Diploma, and I am happy to say that all the rest have secured the Pass Diploma.

Five Prizes are being awarded, namely:—

The Hill Memorial Prize for Silviculture, won by Ram Chandra Kaushik of the Punjab and four College Prizes:—

One for Forest Management, won by Ram Chandra Kaushik, one for Botany, won by Ram Chandra Kaushik, one for Engineering and Surveying won by Mahendra Gupta of the U. P. and the last for the best all-round student and the most practical forester, also won by Ram Chandra Kaushik.

In conclusion, I should like to say a word of farewell to the outgoing students and of welcome to the next, 1944-46, class, who are with us to-day. I think I can truly say to those who are passing out, that, to use a naval phrase, ours has been a happy ship. I trust that although as you go to your various Provinces and States you will be widely separated throughout the length and breadth of India, you will continue to maintain the happy relations with each other and with this College that have characterised your course, and that your common devotion to duty in the guardianship of India's forests will bind you in one brotherhood, not limited by Provincial or State boundaries, but looking to and working for the welfare of India as a whole.

In welcoming those who have just entered the college, I would say that although perhaps you may find the work somewhat arduous and the life strenuous, I hope that yours will also be a *happy ship, and I trust that* all of you will play your part in building up a great tradition for this College and in maintaining that *esprit de corps*, both with those who have gone before you and those who will follow you, which characterises forest officers and forest services the world over.

INDIAN FOREST COLLEGE

List of Students of the 1942–44 Class of the Indian Forest College awarded the Diploma of the College on their passing out on April 1st, 1944.

(In order of merit)

Honours Diploma—

1.	Ram Chandra Kaushik, B.Sc. (Agric.)	Punjab
	Awarded—Hill Memorial Prize for Silviculture.	
	College Prize for Forest Management.	
	College Prize for Botany.	
	College Prize for the best all-round student and the most practical Forester.	

Pass Diploma—

2.	Prithvi Nath Kaul, B.A., M.Sc.	Kashmir
3.	Qudrat Ghani, M.Sc.	Bengal
4.	Shiam Kishore Seth, M.Sc.	United Provinces
5.	Vishwanath Damodar Mehendale, B.Sc.	Bombay
6.	Shivasangappa Revansidhappa Umbarje, B.A.	Bombay
7.	Amar Nath Fotidar, M.Sc.	Kashmir
8.	Shanker Anant Hejmadi, B.A., B.Sc.	Bombay
9.	Mahendra Gupta, B.Sc.	United Provinces
	Awarded—College Prize for Surveying and Engineering.	
10.	Ramchandra Bhaskarrao Mujumdar, B.Sc.	Central Provinces
11.	Nand Kishore Sharma, B.Sc.	Central Provinces
12.	Prabhakar Barua, M.Sc.	Assam
13.	Om Prakash Bhargava, B.Sc.	Gwalior
14.	Subbarao Krishna Swamy, M.Sc.	Mysore
15.	Chinnareddy Jayaram Reddy, M.Sc.	Mysore
16.	Nuruddin Ahmad, B.Sc.	Bengal
17.	Rajkumar Lokendra Singh, B.A.	Jubbal
18.	Muhammed Azizul Islam, B.Sc.	Assam
19.	Raojibhai Ishwerbhai Patel, B.A., B.Sc.	Baroda
20.	Salahud-din Ahmad, B.Sc. (Agric.)	Punjab
21.	Subrahmaniam Pasupathi, B.A., M.Sc.	Central Provinces
22.	Bachan Singh, B.Sc.	Punjab
23.	Sreepal Jee, B.Sc.	Orissa
24.	Sayyid Abdul Aleem, M.Sc.	Bengal
25.	Peter Charles Joseph Fernandes, B.Sc. (Agric.)	Bombay
26.	Dinker Vasantrao Khisty, M.Sc.	Central Provinces
27.	Makhan Lal Saikia, B.Sc.	Assam
28.	Mohammad Mumtaz Ali, B.Sc.	Hyderabad (Dn.)
29.	Ashanka Nand Srivastava, M.Sc.	Holkar State, Indore
30.	Mirza Mohamad Ibrahim, B.Sc., LL.B.	Kashmir.

Mr. C. R. Ranganathan, I.F.S., Director, Indian Forest Ranger College, presented his report as follows:

Report of the Director, Indian Forest Ranger College, on the 1942-44 Rangers' Course.

Sir Jogendra Singh, Sir Herbert Howard, ladies and gentlemen,

On behalf of the staff and students of the Indian Forest Ranger College, I should like to associate myself with the welcome extended to Sir Jogendra Singh by the Inspector-General of Forests. This is the first time that Sir Jogendra Singh has done us the honour of presiding over one of our annual convocations. Knowing as we do how hard it has been for him to tear himself away from his work at New Delhi, we are the more deeply sensible of the honour of his presence here to-day.

This is my fourth convocation speech; I must therefore be careful not to trespass on your patience too much by repeating the things I have said before. As the convocation to-day is a joint one and we have already had the pleasure of listening to Mr. Mobbs' interesting report, I must try and make my report a short one.

Before I proceed to my main business, I wish to call your attention to one important event connected with ranger training which is about to occur in a month or so. After the Madras Forest College closed down in 1938, Bombay started a training centre of its own for rangers and attached it to the Agricultural College at Poona. This centre trained rangers for Bombay Province and for a few of the nearby states. It has now been decided to wind up this centre and to send Bombay students to Dehra Dun. The first batch of Bombay students has already arrived and they are present here to-day. By this decision the Indian Forest Ranger College has become the sole training centre for rangers from all provinces without exception and for all states except Mysore and Travancore.

The outgoing class consists of 35 students drawn from various provinces and states as follows: 2 from Assam, 6 from the Central Provinces, 2 from Coorg, 4 from the North-West Frontier Province, 1 from Orissa, 4 from the Punjab, 1 from Sind, 3 from the United Provinces, 1 from Bastar, 1 from Chamba, 1 from Gwalior, 1 from Indore, 5 from Kashmir and 2 from Tehri-Garhwal. One of the Punjab students was selected for the King's Commission and left the College at the end of the first term. One of the U. P. students had undergone the first year course in the 1941-43 class, but had unfortunately been prevented by ill-health from completing the course. He was permitted to join the second year of the 1942-44 class and is passing out to-day.

After the reopening of the College in 1935, the outgoing class was the first to be formed under the system of annual admissions. That is to say, this class was formed one year after the preceding class was formed and overlapped with it and with the succeeding class by one year in each case.

Staff.—Before the expansion of the College I have just referred to took place, the original full time staff consisted of the Director and an Assistant Instructor. With the doubling of the classes in 1942 the full time staff had likewise to be doubled and the staff now consists of the Director, an Instructor and two Assistant Instructors. There is in addition a Lecturer in Engineering, whose services are shared between this College and the Indian Forest College. Dr. Bagchee, Mycologist, Dr. Chatterjee, Assistant Entomologist, Dr. Gupta, Assistant Chemist, Soils, and Dr. Chowdhury, Wood Technologist, all of them officers of the Forest Research Institute, conducted courses in their respective subjects.

There have been no changes in the staff during the course.

Since this College was founded 66 years ago, it has always been staffed by officers borrowed from the provinces. At the present moment, with the exception of the Instructor

who is a retired and re-employed Conservator of Forests from Bombay, the full time staff, including the Lecturer in Engineering, consists of forest officers lent by provinces for a specified period of employment in the College under the Government of India. The teaching of main subjects, namely, Silviculture, Utilisation, Botany, Engineering and Surveying, is in the hands of the full time staff, which receives considerable assistance from the research staff of the Institute in the teaching of the more specialised auxiliary subjects, such as entomology and mycology. The main subjects are thus dealt with by an impermanent staff, changeable at fairly short intervals, while the auxiliary subjects are taught by a permanent staff. This somewhat anomalous situation has of course certain advantages. The periodic change of personnel enables the College to obtain selected men fresh from the provinces with direct practical experience of forestry under a variety of conditions. The College thus enjoys a wide field of selection and at least in theory can secure men best fitted by attainments, aptitude and experience for its work. There is also advantage that if by any chance an unsuitable man is selected he can be returned to his province without damage to his interests or to those of the College. Now for the other side of the medal. When an officer is posted to the College, he is called upon to do a work very different to that he has been doing in the province. His first two years here are inevitably spent in equipping and preparing himself for his new duties, and he really begins to be fully useful in his province. Unless he is offered and accepts an extension, he goes back and a new officer who takes his place has to pass through a like period of preparation and he too goes back soon after he has learnt his job. Officers thus leaving the College undoubtedly benefit their provinces through their increased and refurnished technical knowledge and through the experience they have gained of practical forestry in several provinces, not to mention the value of their contact with the Forest Research Institute. But it cannot be denied that from the point of view of the College this is a somewhat wasteful arrangement. The problem is not an easy one to solve as it is bound up with service interests and prospects. My present purpose is simply to draw attention to what seems to be a source of weakness in the administration of the College. I will not attempt to suggest a solution now.

The Course.—The ranger course at Dehra Dun is a two-year one, partly theoretical and partly practical. It is widely recognised as a standard course and has served as a model for other similar courses in India and elsewhere. It is worth recalling that it was the first technical forestry course in India and in the British Empire, and that the great forest estate of India has been built up with the help of men who took that course. The curriculum has naturally gone through many vicissitudes. The course originally started as an advanced one being then the only technical forestry course conducted in English in the country. When the provincial forest service courses were started in 1906, the ranger course lost its pride of place as the most advanced forestry course. As experience was gained in the running of the two forestry courses in English, further modifications were made from time to time. This process of adjustment is by no means complete yet.

Speaking broadly, the main function of the ranger course is to train men for practical and executive work, while the officer course is designed to train men for administrative and constructive work. The officer directs and gives orders: the ranger carries them out. In a recent speech to a military audience, Sir Herbert Howard brought out the difference between the training of officers and rangers by means of telling illustration: the officer has to be taught how to make a yield table, while the ranger must know how to use one intelligently.

When the Forest Department was first constituted early in the latter half of the last century, it was placed in charge of miscellaneous, extensive tracts of what may be called residual land: that is, lands at the disposal of Government which were not under cultivation or other forms of utilisation,

and which were not likely to be needed for extension of cultivation in the foreseeable future. Most of these lands carried a degraded jungle, ravaged by fire, theft and unlimited grazing. In those early days the work of the department thus consisted chiefly in the constitution and organization of the forests, their survey and mapping, the opening of communications by means of roads, paths and bridges, and the difficult and essential but thankless task of protecting the forests from the current forms of abuse. These jobs left little time for the pursuit of any intensive forms of silviculture. The department demanded men trained for these jobs and this College provided them.

The second phase of development was the collection of statistical, silvicultural, botanical and utilisational information, their collation, classification and publication, of which the monumental results are Troup's volumes of the Silviculture of Indian Trees, Pearson and Brown's work on the Commercial Timbers of India, not to mention a host of pamphlets, text-books, bulletins, records, etc. In this pioneering and exploratory work the Forest Research Institute played a great part, but the work would not have been possible without the co-operation of the rangers and officers whom Dehra Dun had trained and sent out into the jungles.

We have now arrived at a more advanced stage when, thanks to the preliminary work already done and the industrial development that has taken place in the country, conditions are propitious for the practice of intensive forms of silviculture and utilisation. New problems face us to-day. There is a general awakening of the people to the dangers of erosion and the perils of uncontrolled and improper use of land. There is a general appreciation of the value and importance of forests, not merely as sources of wood and various items of minor produce, but as potent weapons for controlling the destructive forces of wind and water and for restoring and maintaining the fertility of our agricultural lands. In short we have now arrived at the stage when we must practise intensive forestry in all its manifold aspects.

This rough outline of the progress of forestry will serve to show that what we require of a forest ranger to-day is something very different from, something very much more than what was required of him in the eighties of the last century. The courses of forestry at Dehra Dun are not static curricula fixed for all times. They are directly related to the development that has taken place and to the ever-changing needs of the provinces. The teaching here has kept abreast, has indeed kept ahead of the progress of forestry in the provinces. We have also endeavoured to keep pace with the technical advances made not only through Indian research, but also in the field of international forestry.

On previous occasions I have described at some length the subjects dealt with in the course, the tours made in various provinces and the practical work done. There has been no noteworthy change in these respects, and I will therefore not go into these matters again. It would, however, be very remise of me if I did not take this opportunity of expressing our gratitude to the divisional forest officers and staffs of the divisions visited by us in the United Provinces, the Punjab, and the Central Provinces for much kindness and co-operation: to the Commandant, the Superintendent of Instruction, and staff of the Bengal Sappers and Miners, Roorkee, for their excellent course in field works, and to the various railway administrations whose co-operation made it possible for us to tour as far afield as we have done. We are also greatly indebted to the Motor Transport Officers of the 3rd and the 9th Gurkha Rifles for coming to our rescue on numerous occasions by providing motor transport for out journeys by road when we were unable to secure public motor conveyances. I have also to thank the research staff of the Forest Research Institute, especially of the Silviculture and Utilisation Branches, for much valuable assistance in the training of the students.

The Common Mess.—It is now a condition of admission to the College that all

students shall eat together in a common mess. The mess was started in 1941 and has worked satisfactorily these three years. The great increase that has occurred in the cost of living was a handicap in the normal development of the mess, but it is unquestionably true that had it not been for the institution of a common mess with the attendant economies in service and catering, the students would have been much harder hit than they have been.

The Stipend.—The College rules provide that each student shall have the spending of not less than Rs. 50 per mensem during the twenty-four months of the course. We are not primarily interested in whether this sum is found by the provinces and states deputing the students or by the students themselves, although we have always recommended that monthly stipends should be granted by the provinces and states. Our rules require states sending students to the College to deposit the total amount of the stipend for the course with the Director. Provinces not granting stipend are similarly required to collect the total amount of the stipend from the parents or guardians of the students and send it to the Director. In point of fact all provinces grant stipends, except only the United Provinces which pays a stipend but recovers it subsequently from its students after they join service.

In normal times the monthly stipend of Rs. 50 was a reasonably liberal allowance which left a small margin for personal expenditure after the food charges and the compulsory College deductions had been met. In 1942 this margin disappeared and in 1943 the cost of living rose so high that notwithstanding the economies enforced in diet and services, the stipend no longer sufficed to meet even the obligatory expenditure. It was considered inexpedient to raise the value of the stipend fixed in the rules but we strongly supported petitions from students for the grant of dearness allowances. I am glad to say that in response to these petitions most provinces and states have granted dearness allowances of varying degrees of liberality. I hope that the remaining provinces will also see their way to granting dearness allowances to their students.

Games and Sports.—As always, we lay great stress on physical fitness. Physical training is a regular item of daily routine at Dehra Dun and games are compulsory in the evenings. About six months after they join the College, all students show a marked improvement in bearing, physique and weight. The outgoing class played a number of matches in football, hockey and volleyball. The class cannot lay claim to any special distinction in sports and athletics, but on the whole did fairly well in games.

Health.—There has been no case of serious illness in the outgoing class and the health of the students has been good.

The Results.—Out of the 35 students in the class, one student was prevented by his personal circumstances from appearing in the final examinations. With the approval of the President, he has been credited with his own past average marks for the final examinations and awarded a Higher Standard Certificate. It has, however, been decided not to rank him in the general list. Of the remaining 34 students, one secured the coveted distinction of an Honours Certificate. In respect of honours, the outgoing class has fallen behind its predecessors in recent years. I regret to say that a lower standard certificate had to be awarded to one student.

INDIAN FOREST RANGER COLLEGE, DEHRA DUN

Result of the 1942–44 *Course.*

Serial Number in order of merit.	Total marks obtained out of 4,700.	Name of Student.	Province or State.	Certificate.
1	3,566	M. S. A. Khan	U. P. ..	Honours.
2	3,473	T. C. Sur	C. P. ..	Higher Standard.
3	3,463	S. S. Husain	U. P. ..	do.
4	3,451	Maghfur Ilahi	Punjab ..	do.
5	3,415	R. L. Vig	Kashmir ..	do.
6	3,406	A. S. Gulati	N. W. F. P. ..	do.
7	3,355	S. Hassan Saeed	N. W. F. P. ..	do.
8	3,355	Ghulam Hanif	Punjab ..	do.
9	3,350	G. Mohyuddin	N.W.F.P. ..	do.
10	3,318	P. N. Gandotra	Kashmir ..	do.
11	3,317	N. A. Masoodi	Kashmir ..	do.
12	3,313	S. S. Srivastava	C. P. ..	do.
13	3,192	P. C. Bhor	Indore ..	do.
14	3,191	Jagdev Singh Sidhwan	Punjab ..	do.
15	3,191	T. R. Mahanta	Assam ..	do.
16	3,188	S. A. Shah	Baroda ..	do.
17	3,174	Satya Vrat	Chamba ..	do.
18	3,174	C. K. Puthia	U. P. ..	do.
19	3,121	P. P. Lele	C. P. ..	do.
20	3,091	Khalid	N. W. F. P. ..	do.
21	3,090	Partap Singh Parmar	Punjab ..	do.
22	3,067	R. G. Mehta	C. P. ..	do.
23	3,063	J. G. Thosre	C. P. ..	do.
24	3,011	R. P. Joshi	Tehri ..	do.
25	2,990	Ijjad Ali	Assam ..	do.
26	2,981	P. L. Vishwakarma	Bastar ..	do.
27	2,966	U. C. Singh	C. P. ..	do.
28	2,941	H. K. Devappa	Coorg ..	do.
29	2,930	M. S. Rama Rao	Coorg ..	do.
30	2,896	G. R. Malik	Kashmir ..	do.
31	2,822	J. K. Mohanti	Orissa ..	do.
32	2,821	Abdur Rahaman	Kashmir ..	do.
33	2,820	J. K. Moorjani	Sind ..	do.
34	2,453	M. J. Rana	Tehri ..	Lower Standard.
..	....	P. G. Deshmukh	Gwalior ..	Higher Standard.

INDIAN FOREST RANGER COLLEGE, DEHRA DUN

List of Prize Winners—1942–44 *Course.*

Serial No.	Name of Prize.	Name of Prize winner.	Province.
1	*Honours Gold Medal*— .. .. (To the student gaining most marks in all subjects throughout the course).	M. S. A. Khan ..	U. P.
2	*Silver Medal for Botany*—	M. S. A. Khan ..	U. P.
3	*Silver Medal for Forest Engineering*	R. L. Vig ..	Kashmir.
4	*Silver Medal for Forestry*	T. C. Sur ..	C. P.
5	*Fernendez Gold Medal for Utilisation*	A. S. Gulati ..	N. W. F. P.
6	*McDonnell Silver Medal* .. .. (To the best student from the Punjab or Kashmir).	Maghfur Ilahi ..	Punjab.
7	*William Prothero Thomas Prize* .. .. (To the best practical Forester).	N. A. Masoodi ..	Kashmir.
8	*"Indian Forester" Prize* .. .. (To the best student who has received no other prize).	Ghulam Hanif ..	Punjab.
9	*Director's Prize* .. .. (To the second best student who has received no other prize).	S. Hassan Saeed ..	N. W. F. P.
10	*Marathon Cups*—		
	(1) Inspector-General of Forests' Cup ..	N. A. Masoodi ..	Kashmir.
	(2) Second Prize	Partap Singh Parmar ..	Punjab.
	(3) Third Prize	Ijjad Ali ..	Assam.
11	*Hazarika Memorial Prize* .. .. (To the student gaining highest marks in tour examinations).	S. S. Husain ..	U. P.

Address by the Hon'ble Sir Jogendra Singh, Member of H. E. the Viceroy's Executive Council, in charge of the Department of Education, Health and Lands.

Sir Herbert Howard, Ladies and gentlemen,

I have listened with great interest to your reports of the working of the Indian Forest College as well as that of Forest Rangers' College.

My interest is not an expression of conventional sympathy; it is rooted in the knowledge of the needs of my country. We must conserve our forests and carry out further afforestation to protect our land and to support our primary industry—agriculture. We must, therefore, provide for the training of those who can plan, guide and direct and others who can execute the plans with confidence and care.

We shall need, as our development plans mature, an additional corps of officers fully equipped with the requisite scientific knowledge to extend their activities to seven hundred thousand villages which make India. We must plan for the training of additional staff from now and expand considerably facilities for training if men are to be available to carry out our plans. I am asking the Inspector General of Forests to work out a project of the future requirements to provide for the training of increased number of students in both your Colleges.

There are one or two aspects in our system which strike me as incongruous. It does not seem right that there should be frequent changes in the staff. Your Director observes that the officers secured from the provinces for the College spend first two years in learning and preparing themselves for their duties, but as soon as they have done this, they preen their wings for departure. No teaching institution can acquire a tradition and function in full power which depends on a migratory teaching staff.

Another matter that strikes me is the lack of link between the Rangers' College and the Indian Forest College. It may be useful to provide such a link. I am not in a position at the present stage to make a pronouncement on these matters, but these matters are likely to be under active consideration of our experts.

I am glad to say that it was given to me to accord recognition of the Diploma of the Indian Forest College and allow the right to use A. I. F. C. after the names of those who qualify.

Somewhere in his opening address, Sir Herbert Howard said that the Forest Research Institute need not be ashamed of its contribution to the war effort. Indeed it has every reason to be proud of its achievement. It has solved many problems which have led to the starting of a number of factories and thus providing paying employment for labour. Your research workers have shown how to protect timber from insect damage, how to manufacture ephedrine, extract medicinal creosote from pine-wood, cream rubber latex, how to make diluents for rubber and size textiles. They have produced substitutes for certain important waxes, made numerous containers to pack Ordnance stores and adhesives required for all forms of laminated wood. They have made compregnated wood which is being used at this moment for the manufacture of air screws for the Royal Air Force.

I read carefully the Monthly Report of war research undertaken by the Institute. In the month of February alone, the Institute advised the Master General of Ordnance on packing materials for bottles and medical stores, examined samples from the aircraft timber depot to discover defective timbers, tested certain aircraft spruce and fir sent by the Timber Directorate, worked on *semul* tea chests to save shipping space on imported shooks, advised on seasoning timber for the manufacture of air screws, made samples of stern tube bearings of a twin screw barge from compregnated wood of *toon*, supplied compregnated shuttle blanks, continued to convert *bonsum* for test fans, repaired propellers, made wax-sized paper for maps, trained war technicians, investigated the protection of *salai* logs for ammunition boxes, investigated certain resin from

pine stumps to see whether it possesses the necessary qualities to consolidate earth for making aeroplane runways, etc. etc.

Out of the 49 publications reviewed in the last issue of the *Empire Forestry Journal*, nearly 50 per cent were publications of this Forest Research Institute. This is an indication of the increased work at the Institute and calls on the time of the I. G. of Forests.

Before 1926 there were both a President of the Institute at Dehra Dun and an Inspector General of Forests with his headquarters with the Government of India like all other Heads of Departments. The post of the I. G. of Forests and that of the President of the Forest Research Institute were combined in 1926 in the interests of economy and in the hope that with the coming of provincial autonomy the calls on the time of the I. G. of Forests would not be so urgent. I find that the I. G. of Forests can no longer efficiently combine the two posts if he is to help the provinces and States with his advice on the one hand and remain in full charge of the Forest Research Institute on the other. I have revived the post of Vice-President who will be practically the head of the Institution. It may and probably will lead to complete separation of the posts of I. G. of Forests and the President of the Forest Research Institute to enable the I. G. of Forests to return to the headquarters of the Government of India.

This new arrangement has set free the I. G. of Forests to help the provinces and States in the development of their forest resources. Sir Herbert Howard has already done some very useful touring. I am hoping as a result of the contacts he has established that we shall evolve an all India forest development policy, founded on the willing co-operation of provinces and States.

There are a great many problems to be considered directly when the war is over. Some of them are facing us now. As a layman I feel that there are three main problems which outweigh all others in importance. These problems are, *firstly*, to bring the existing reserved forests back to their pre-war position and to produce the maximum sustained yield of which the soil is capable; *secondly*, the problem of run-off, floods and erosion and its consequence, the problem of areas that are becoming dry and unproductive: an enormous tract of land is crying out for afforestation; *thirdly*, the urgent problem of bringing forests to the help of agriculture.

The best example of agriculture is seen in operation in our forests. The trees protect the soil from direct action of sun. They weave a canopy of leaves to break up the rain into spray which converts litter of plant and animal refuse into food for the soil. The trees not only give fuel and timber but turn the winds into gentle currents, control and conserve moisture. There is a remarkably little run-off of rain from primeval forests.

I do not propose to say much about the first problem. I understand that excessive fellings due to meet war demands have not affected our reserved forests from the point of view of protection from floods and erosion. Over-felling there has certainly been and these advance fellings have been made on the best trees in the most accessible areas. It is not possible to calculate its immediate effects. It will need years of careful nursing to fill the gaps. Many intricate problems will arise to bring these forests back to full production. Such problems, however, difficult though they may be, are not new. They are exactly what you have been trained for.

The second problem of run-off, floods and subsequent erosion, is perhaps the most important single problem facing India, nay the whole world, to-day. Those of you who have seen what happened in Hoshiarpur District, the hideous ravines of the Jumna and the Chambal, and the terrible devastation in the Punjab foot-hills, know the extent of the damage that has already been done. This is not the end of the story. Erosion is removing soil from areas not so easily noticed. You have seen how muddy the rivers become after a heavy shower of rain. The quantity of such soil taken away in this way by rivers and even small streams is almost incredible. This process continues from year to year.

This is not the only form of loss of soil. In the desiccated areas of Rajputana, wind erosion alone has removed, I am told, as much as six crores of maunds of soil per square mile in certain places during the last 100 years. The hot dry winds sweeping across these desert or semi-desert areas dry out even the meagre rainfall which they receive. At Jodhpur, which gets about 13 inches of rain, the surface evaporation of water is about $7\frac{1}{2}$ feet per year, a terrible state in an area of scanty rainfall.

The general problem of soil conservation is of utmost importance both for Forest and Irrigation officers. If the run-off at the head-waters of streams could be controlled, much of the subsequent damage would be avoided. It is disforestation of areas in the Himalayas and the northern part of Central India which causes floods in the Ganges and affects the health and happiness of the people of Bengal. The problem, therefore, goes far beyond the provincial and State boundaries.

Sir George Stapleton of the British Ministry of Agriculture, holds that man's attitude towards the problem of erosion is the supreme test of his wisdom. In India the problem has not yet received the attention that it deserves. The preservation of forests and afforestation of new areas is of supreme importance to agriculture.

I have been dreaming from my boyhood for a better life for our people. In my closing years I am anxious to rescue from the ghost-land of hopes and possibilities some tangible plan to relieve poverty by developing new sources of production and employment and prevent ill-health by providing well-balanced diet for our increasing population.

I now come to the problem directly connected with agriculture. Taking very rough figures the area of British India is approximately 800,000 square miles. Of this, about 400,000 square miles, or roughly half, is either cultivated land or current fallow and just over 100,000 square miles is forest that is 13 to 14 per cent of the total.

I hold that most of the area classified as culturable is capable of yielding crops or trees or grass. Areas which cannot produce crops can produce trees and there is room for developing village forests. With this view my friend, Sir Herbert Howard entirely agrees.

There is nothing basically wrong with Indian soil. The reserved forests of India, which have been properly managed for the past 80 years, compare favourably in production with the best European forest soils. An average quality oak or beach forest in Europe produces about 95 c. ft. of timber and fuel per acre per annum, while an average quality *sal* forest in India produces well over 100 c. ft. per acre per annum. Or if you turn to coniferous species, our average production per acre is 130 c. ft. per acre per annum of *chir* pine to 90 c. ft. of timber and fuel of Scots pine forest. Forest soils in India produce at least as much as forest soils in Europe. Nor is this only true of forest crops. On freshly cleared forest soils, the wheat crop has produced twice as much per acre as on ordinary zamindari agricultural land. On a well manured farm in the Punjab wheat yielded 50 maunds to the acre.

Our problem is to provide the villager with wood to burn instead of cowdung. I am frequently pressed by my friends in the Legislature to procure and produce chemical fertilizers. I am doing all I can to meet their wishes, but I feel that our first duty is to secure the cowdung for the land which is calculated to give 250 million tons, capable of manuring 72 million acres or 30 per cent of our sown area. An additional quantity of food for soil and for our livestock can be secured by crushing all the oil seeds in the country itself.

The effect of manure on crop production varies considerably. But assuming that the food production on manured area would be approximately trebled, it means that this cowdung, used for its legitimate purpose as manure and not burnt, would increase the total food production of India by some 50 per cent. The peasant is extremely conservative and

extremely poor. He is not always easy to convince of the advantage of chemical manure and he is too poor to buy them even if he were convinced. But he needs no convincing of the value of cowdung as manure.

Now a glance at any map showing the distribution of forests in India will convince you that the villager burns cowdung because he has no other source of fuel. He has no village forests which could supply him with timber and fuel. This is especially true of the northern half of India from Karachi to Calcutta. What we need is creation of forests at the villager's doorstep. Land is undoubtedly available to grow these small agricultural forests. Cultivation and forests occupy over 500,000 square miles leaving 300,000 square miles of waste land available in British India. It is undoubtedly possible to find at least another 100,000 square miles capable of growing short rotation agricultural forests. Sir Herbert Howard has been examining the problem and he is confident that suitable land exists and he can raise forests. He does not exclude the whole of the dry areas of Sind, the Punjab and Rajputana. Where irrigation is available, there is no difficulty whatever in growing forest even in areas of under 5 inches rainfall. Plenty of such forests can already be seen down the Indus both in the Punjab and in Sind. Sir Herbert Howard tells me that in areas of an average rainfall greater than 12 inches the problem, though difficult, can be solved and becomes increasingly easier as the rainfall increases. Naturally the forest in these low rainfall areas will be of poor type, but it will provide the fuel and small timber which the agriculturist needs, and above all a blanket of vegetation to stop the evaporation from the soil of whatever rainfall it gets. The Forest Department are now engaged on the problem of trying to afforest areas with a rainfall of even less than 12 inches. We shall watch their experiment in expectation of good results. But areas with rainfall above 12 inches include everything north and east of a line running roughly from Zhob to Bannu, across to Lyallpur, then south through Bikaner to the borders of Jodhpur and then south-west to the Rann of Cutch.

Our plans visualise the creation of another 100,000 square miles of forest in British India, thus doubling the present area, which would be just about the correct percentage of forest for a country like India.

Sir Herbert Howard holds that the growing of short rotation agricultural forests is not a dream of the distant future. The rotation of such forests will be 15 to 20 years and the first return in fuel will come from thinnings within 5 years of planning. Nor will it reduce grazing. It will mean regulating the grazing, but this type of agricultural forest properly managed with regulated grazing will not produce less fodder than the present haphazard arrangement. It will produce infinitely more fodder and thus support well bred livestock in good condition.

I must weary you no more with my speech. I wish you all godspeed in a career of great importance to your country. If I may, I would add a few words to the advice given by your President.

The journey of life's conquest becomes easier if we seek agreement with our fellow travellers and join hands in doing that which needs our united effort. The moment we stop working together, disagreements arise and it is all over.

In the word of that wise man Ruskin, "After six thousand years of thinking about right and wrong, wise and good men have agreed upon that God dislikes idle and cruel people and His first word is "work while ye have light" and His second is "be merciful while ye have money."

Remember—

"A voice like a breath from the wings of a dove:

Would you drink of earth's wine, you must store it in love."

EXTRACTS

THE FOREST RESEARCH INSTITUTE, DEHRA DUN

In a dispatch of the Governor-General in Council, India (dated November 1, 1862), which merits a closer study than some parts of the Empire and Commonwealth appear to have given it, the formation of an Indian Forest Service with an Inspector-General of Forests at its head as adviser to the Governor-General was advocated, in order to check the excessive exploitment and waste of the forests of that country, which had been greatly intensified with the increased demand following the establishment of ordered rule, and to reserve and conserve selected forest areas. In sanctioning the proposals, the Secretary of State for India wrote that whereas capital expenditure might and would be justifiably spent in ameliorating ruined forests and in opening out inaccessible ones, he was assured that the work projected would result in a valuable forest estate accruing, which in due course, in addition to being of the greatest benefit to the people, would bring in an increasing revenue to the Government. This inspired prophecy was abundantly fulfilled.

Yes, something more than half a century later, so incalculable is the potential value of the great forest estate in India, that the Government of India wrote (to the Secretary of State), "the greater part of our forest properties are undeveloped." The subject then in question was research and the Forest Research Institute at Dehra Dun. This was inaugurated in 1906, a research building erected and opened in 1912 and soon after came the war of 1914-18. Imports of many material products in common use in India came to an end, and the young Research Institute was called upon to investigate the possibility of replacing them with raw materials from the forests. The success achieved is common history. The second dispatch, from which the above sentence is quoted, proceeds to point out that the existing research buildings were totally inadequate to the demands of the Institute and proposed, in addition to considerable increases of the research staff, the purchase of a site of 1,200 acres and the erection of a new Institute building, workshops, residencies, etc., at an estimated cost of close on a million pounds sterling. This great scheme was sanctioned by the Secretary of State, and the new Institute building was opened some seven years later by the Viceroy.

Once again war supervened: and once again India was faced with a closure of imports and the necessity of falling back on her own resources. For the second time the Forest Research Institute, now immensely stronger, has proved able to give invaluable services.

A recent publication, "Forest Research in India and Burma, 1941-42. Part I. The Forest Research Institute" (Dehra Dun: Forest Research Institute, 1943. Pp. iv-151. 1s. 11d.), summarizes some of the work carried out. "Even more than last year," says the writer, "the work of the Institute has been dictated by War, in fact in certain sections and branches practically all work on ordinary programmes has been suspended to deal with war research. Whilst the branches dealing with Silviculture, Botany, Mycology, Chemistry and Entomology have only dealt in most cases, more or less indirectly with war problems, though their assistance has been solicited on occasions, the brunt of the work has fallen, as was the case during the last War, on the Utilization Branch, which throughout has had to devote its whole time to war work."

During the year this branch has been continuously evolving substitutes for which there was a shortage for one reason or another as a result of the War. In conjunction with the Mechanical Section, the Wood Working Section has devoted its energies entirely to the demands of India and the Army. Containers of many types down to the ordinary pail, and for a variety of purposes, were constructed of plywood, on the basis of researches at the Institute, and were afterwards manufactured at factories. The Wood Technology Section spent the year identifying timbers mostly for the Army, but was also concerned with the

selection of the right type of timber for aircraft. It also trained in timber identification sixty men of the Ordnance and Military Engineers Services Departments. Ammunition boxes, walnut wood for rifles and other researches were undertaken by the Timber Testing Section; while the Seasoning Section advised on the installation of kilns in various parts of India and also developed a simple hot-air kiln for quickly completing the seasoning of partially air-dried half-wroughts for such material as tool helves, shuttles, bobbins, picker-arms, etc. Unseasoned wood is useless for many of these purposes. The adhesives for plywood investigations have been already alluded to (*Nature*, Jan. 29, p. 144). The Paper Pulp Section continued to work throughout the year, guided to a large extent by the Advisory Committee of the Indian Paper Makers' Association, there being a general shortage of paper in the country.

Some interesting research in the Chemistry Branch, carried out owing to war shortage, included a simplified method of preparing ephedrine and its salts from Indian Ephedras. This has been started on a factory scale, so that ephedrine salts are now being produced to replace the imported article. Retorts have been installed, as a result of experimental work, for the large-scale distillation of *chir* (*Pinus longifolia*) tar: the perfected process in these retorts will now yield products not only suitable for use in rope and rubber works but also for medicinal purposes. Tamarind seeds were shown to be a cheap source of pectin. A large amount of work was also carried out on charcoal for producer gas.

Truly has the great value and usefulness of her forests to India in times of stress, as in those of peace, justified the foresight of that Secretary of State in the distant days of 1862.—*Nature*, Vol. 153, No. 3876, dated February 12, 1944.

THE WAR AGAINST MALARIA

By Harold N. Moldenke

In the steaming jungles of the Solomons and the dank forests of New Guinea, on the dark miasmatic rivers of Burma and the wild shores of Guadalcanal, the foremost enemy of the American troops is not the Japanese, but *malaria*! General MacArthur has reported that the battle of Bataan was lost not only through lack of ammunition, but also through lack of means of fighting the malaria, from which 80 per cent of his front-line troops were suffering 10 days before Bataan fell.

To the soldiers stationed in the Canal Zone, in Trinidad, in Guiana, and Brazil—to the hundreds of thousands of rubber-tappers and their families in the dense jungles of the Amazon—malaria is a far greater danger than venomous serpents or ferocious beasts of prey!

Malaria kills about 3,000,000 persons throughout the world each year, and there are at least 800,000,000 cases of malarial fever. In the war efforts of the United Nations this deadly fever is becoming increasingly more menacing as the number of men stationed in tropical malarious regions increases.

The war against malaria is an unending battle against three (perhaps four) types of protozoan parasites of the genus *Plasmodium*, which pass one part of their life history in the *Anopheles* mosquito and the other part in man. When the parasite gets into the human body it enters a red blood cell, where it promptly multiplies (without sexual processes) until the cell bursts, releasing the parasites and the stored-up poisonous products. The released parasites enter other blood cells and repeat the process. The toxic materials enter the serum of the blood and are distributed throughout the body, causing chills, fever, digestive disturbances, loss of strength, frequently collapse, and in many cases death.

Among the parasite's vast progeny there is always a small percentage, called gametes, which are male and female and cannot reproduce separately. These remain in the blood cells in a quiescent state. If a mosquito, in biting a patient, draws some of these gametes

into her stomach, they will start reproducing by sexual processes and will produce offspring that can reproduce asexually if injected into another human being. The gametes live only about one month, but any time a person suffers the "flare-up" he becomes a potential carrier of the disease. In addition to the victims who die, many others who have caught it continue to suffer its effects for years. In some tropical regions it is estimated that one-third to half of the population has malaria.

Man's only remedy against malaria for three centuries has been quinine, extracted from the bark of the *cinchona* (pronounced *sin-ko-na*) or "fever trees" of South America. Cinchona was apparently known to the shamans or priests of the Inca empire long before the coming of Europeans to the New World and was known as *quina-quina*.* The discovery of its medical values certainly ranks as one of the major events in the history of the New World.

The story of the arduous and danger-fraught search for the best cinchona trees by the famous naturalist-explorers, Richard Spruce, and others, forms another romantic chapter in the history of quinine. Success was finally achieved about 80 years ago when Charles Ledger, an Englishman who had lived in Peru and Bolivia for 20 years, obtained 14 lb. of a very superior strain of cinchona seeds. Failing to interest the British Government in his project, he sold a pound of these seeds to a Dutch Government official, who took them to Java. This was the humble beginning of Java's quinine industry in the Preanger mountains, through which, in time, Java was able to supply the world's annual quinine requirement. In peace-time it amounts to 650-750 tons, in war-time (1941) 1,017 tons.

Cinchona is a large genus of plants most of which are native to the forests on the eastern slopes of the Andes from Colombia and Venezuela southward through Ecuador and Peru to Bolivia. Peru alone has some 75 species, of which at least 15 have been used for their bark. Although about 90 per cent of the world's supply before the war came from the Dutch East Indies or was distributed through Dutch interests, cinchona cultivation has also been undertaken on St. Helena and in the Cameroons, Tanganyika Territory, Malaya, Madras, and Bengal: but numerous failures have been reported. After Java was overrun by the Japanese, the Dutch took measures to render the factories useless. Now frantic efforts are being made to locate cinchona trees in their original homes and develop a quinine industry in Latin America which will make the New World independent in regard to this strategic drug.

Farsightedly, in 1920, the Director of Forestry in the Philippines bought a pint of cinchona seeds for $4,000. Before the fall of Bataan, 2,000,000 precious seeds were brought back to the New World from the Philippines. More than 100,000 seedlings are now ready to be planted on 10,000 acres in Costa Rica. The most favourable areas there are from 4,000 to 6,000 feet above sea level. Cinchona does best where the dry season does not exceed a month and a half. Seedlings are already growing in Brazil, and plantations have been started in Mexico, Venezuela, and Colombia. The greatest present activity in this respect is in Guatemala, where 3,000,000 seedlings have been distributed and 300,000,000 more seeds are being planted. The establishment of such new plantations, of course, will not produce quinine in time to assist in the present war effort, but is part of a long-term project for the development of a permanent New World quinine industry.

Chemically quinine has the formula $C_2O_0H_{24}N_2O_2$. Cinchona bark contains not only quinine, but also *quinidine* and certain other white crystalline alkaloids, especially *cinchonine* and *Cinchonidine* (C_{19} H_{22} N_2O). Quinine is fundamentally a protoplasmic poison and if taken in too large amounts will break down the protoplasm of the human body instead of just the protozoa which cause malaria. It is usually administered in the form of quinine sulphate.

* That the Incas used the remedy first is sometimes disputed. If they did not, the early Jesuits must have discovered it on their own.

Two chemical compounds have been developed synthetically which are helping to replace quinine. One, *plasmochin* (or *plasmoquine*), announced in 1924, will not kill the protozoa which quinine kills, but will kill the quiescent gametes. The second is *atabrine* (or quinacrine hydrochloride) announced in 1933, which will kill the asexual stage. Other compounds on which work has been done are undecane diamidine, stilbene diamidine, promin, and sulfadiazine. However, the synthetics, while representing a distinct forward step in malarial therapy, can never completely replace real quinine, because the latter may be taken by any one without a doctor's care or prescription, while strict medical supervision is generally essential in taking the more dangerous synthetics.

The cinchona bark obtained from South America does not contain as much quinine as that from Japanese-held territory because years of careful breeding and selection have contributed to the high-content strains of the Dutch East Indies. However, other components of the South American bark with antimalarial action can be inexpensively and efficiently extracted to augment our supply of antimalarials.

The delicate white crystals of quinine are not the only product of worth that is extracted from the bark. Other active medicinal substances are also procured. The yellowish-brown powder called *totaquine* is a well-tried and reliable agent capable of replacing quinine in almost all instances, although it is only half as potent, requiring doses of 30 grains a day. Totaquine will probably largely replace quinine in the United States during the present war while precious quinine stocks are shipped to the armed forces. Like quinine, under present governmental restrictions it may be used only for the treatment of malaria. Totaquine has thus far not been rendered stable enough to allow its shipment to fighting fronts. The huge army of *cascarilleros* or quinine gatherers in South America must also have their antimalaria medicine while gathering the bark. Some 45,000,000 tablets of atabrine are being reserved for them. Atabrine is now being produced at the rate of about half a billion tablets a year, although many doctors still prefer natural quinine to atabrine synthesized in the Laboratory.

The bark of the Ecuadorean "fever-tree" was for a long time surreptitiously added to the more expensive bark of the Pruvian balsam (*Myroxylon peruiferum*). The name "Peruvian bark" clung to cinchona even after it was separated from the balsam in commerce. For two centuries the only source of cinchona was the forests of the eastern Andes from Colombia to Peru. Increased appreciation of the tremendous medicinal values of the drug led to increased demand. This, in turn, led to the establishment of the Dutch plantations and, in 1859, to the extensive programme for cinchona plantations in British India. Originally all the quinine came from *Cinchona officinalis*, but in recent decades *C. ledgeriana* has provided almost the entire supply. Quite a different species, *C. Succirubra*, as bark which rarely yields more than two or three per cent of quinine. It is mainly used as a stock plant on which to graft the less vigorous *C. ledgeriana*, which averages seven per cent or more of quinine in its bark.

Cinchona trees are not easy to grow in cultivation, since their soil and climatic requirements are quite exacting. They must be several years old before any bark can be harvested, and peak production is not attained until they are ten years old. In harvesting, the entire trees are uprooted and the bark is removed by beating the trunk, larger branches, and roots with wooden mallets and stripping by hand. After the trees have reached a certain age the increase in quinine content slows down considerably. For this reason most plantations operate on an 8, 10, 15, or even 20 year rotation, depending on whichever time-period will bring the most efficient harvest in a given soil and climatic environment. An 8-year schedule, for example, means the cutting down of one-eighth of the total acreage annually and the replanting of an equal amount of young trees. After stripping, the bark is dried and ground to a coarse powder

for shipment to the manufacturers, who extract the quinine and other chemically desired alkaloids.

In recent years shipments of quinine to the United States have averaged over 1,700,000 pounds annually, valued at $735,000. About 98 per cent of this came from the Dutch East Indies, but the cinchona industry never really died out in the New World. Bolivia, for instance, has had quite a thriving industry for many years and in 1938 exported about 2,000,000 pounds of the bark to Europe. Plantations which were made many years ago in Ecuador, Colombia, and Guatemala still exist.

The original cinchona bark of European and American markets was in the form of "quills." These are narrow strips of bark, which roll up in drying. They were used not only to extract quinine for treatment of fever, but also to a lesser extent in other medicines, for the medication of wines and other beverages, in toiletries, and for culinary purposes.

Exploring botanists are discovering great numbers of wild cinchona trees in sections of South America where they had not previously been known to exist in commercial quantities. In Ecuador alone there are said to be some 10,000,000 wild trees. The transportation of the bark from the depths of the jungles is a fascinating story filled with romance and danger. The bare backs of natives, mules, hand-propelled river barges, railroads, ships, and even airplanes all figure in this story. Recently an urgent request for an outboard motor was telegraphed to Washington, and the motor was rushed down to Peru by air mail to test the feasibility of moving bark along a certain inland river on an outboard-driven barge. A hitherto undeveloped stand has been located in the Balsapampa region of central Bolivia. Because there are so few trails into this remote area, the regular method of penetration has been on rafts, along the rivers. Plans now call for clearing a landing strip for airplanes in the midst of the forest. An exploring party entering the region by plane returned in 45 minutes, but it took 22 days for some of the bark to be brought out on foot by the Indians!

So the tentacles of war are reaching even into the most isolated and hitherto inaccessible jungle lands of central South America!—*Natural History*, January 1944.

"QUO VADIS?"

Stocktaking at occasional intervals is a business practice of long standing that might advantageously be followed by those engaged in the professions. Perhaps it offers a more useful way of celebrating the advent of a new year than the adoption of resolutions that are seldom kept. Where, then, does forestry stand, and what action does the condition of its stock indicate?

Both questions permit of interminable argument, partly because the facts themselves are difficult to determine, and partly because their significance depends so largely on the point of view of the interpreter. Nevertheless the highlights of the picture are reasonably clear, however obscure the details. On the whole, the outlook is neither as dark nor as bright as those who view with alarm or those who view with complacency would have us believe.

Continuous production is assured on most of the forest lands in public ownership, and substantial progress toward better management is being made on those in private ownership; but adequate protection from fire, insects, and disease is yet to be achieved, the volume of the growing stock is still decreasing and its quality deteriorating, and annual drain continues to exceed annual growth. Forest research and forest education have made notable progress, but too little use is made of the improved methods and the trained personnel that they have produced, particularly by private owners, operators, and manufacturers. The general public believes that forestry is a good thing, but has only a vague understanding of its meaning or its importance. Foresters have a professional organization dedicated to promoting the science, practice, and standards of

forestry in America, but its influence in these directions is weakened by a relatively small membership, inadequate financial support, and lack of agressive leadership.

In brief, forestry has made a good start but still has a long, long way to go. To go where? On that point there should be little difference of opinion among foresters, timberland owners, wood manufacturers, legislators, or others. Few will agree with a prominent lawyer from the Upper Peninsula of Michigan used to say that the world could get along perfectly well without wood but not without forests. What he meant was that wood is an outdated material for which plenty of satisfactory substitutes are now available, but that nothing can replace the forest as an ameliorator of climate, a conserver of soil and water, a place for healthful outdoor recreation, and a source of spiritual inspiration. He was an advocate of multiple use who could not be accused of unduly favouring "sawlog forestry"!

The truth of course is that wood is so far from being obsolete that its use is at present increasing, not only because other materials are scarce but because for many purposes it is intrinsically superior. New products and new processes hold out the possibility of almost unlimited expansion. The age of wood may well be ahead of us rather than behind us, provided ample supplies are available at reasonable prices. Clearly the national interest will be furthered by a policy that seeks an abundance rather than a scarcity of wood *and* other forest values under a balanced programme of land utilisation. Such a programme calls for far more widespread and effective management of the forests than now exists with all forest properties handled under specific plans suited to their biologic and economic environment.

This is a goal that should be at once an inspiration and a challenge to every forester and every forest owner in the country. Opinions will inevitably differ widely as to the best means of obtaining it. This will delay the adoption of particular measures but not necessarily arrival at our final destination, Group decisions resulting from the clash of ideas are likely in the long run to be as sound as those made by a single individual or organization, and much more likely to command the public support necessary to make them effective.

The first essential is that our discussions be guided by a sense of purpose. It is a waste of time to argue about routes until we know where we want to go. If we are agreed on that, then we can argue intelligently, and if necessary violently, about how best to get there.

Two major dangers to be avoided are those of confusing the means with the end and of letting our emotions run away with our intellects. When one feels intensely, either pros or con, about some subject such as federal acquisition or federal control of forest lands, he is apt to regard it as an end in itself rather than as one of several possible ways of attaining the real objective of better forest management, and to question the sincerity, the motives, and the good faith of those who do not share his views. The result is not conductive to clear thinking or to a meeting of minds. Too often the real issue becomes buried in a maze of irrelevancies and personalities. Sharp differences of opinion are to be expected, but there is no reason why they should not be fought out on their merits, vigorously to be sure, but openly, frankly, and with a minimum of ill feeling.

To-day the increased cutting brought about by the war, and the prospects for a continuing heavy demand for wood to supply the needs not only of our own country but of other parts of the world, have emphasized the need for speeding up progress in the better management of our forests. Any objective appraisal of our situation will show that it is far from satisfactory. Numerous individuals and organizations, both public and private, are devising plans as to what should be done about it. This is encouraging, even though the prescriptions of the several doctors vary widely, but it is enough?

Have not the foresters of the country an opportunity and a responsibility to take a more active part in the formulation of plans and policies through their own organization, the Society of American Foresters? This

body, composed as it is of men in all branches of forestry and all types of employment, and free from the restrictions imposed on them as employees of a federal agency, a state department, or a private company, is in a unique position to speak for the profession as a whole. It includes persons holding just about every conceivable opinion on every conceivable subject, and it provides a forum through which these opinions can be presented, debated, and so far as possible harmonized. It is potentially the agency *par excellence* to consider comprehensively and dispassionately all forest problems, whether in the fields of policy or practice, and whether controversial or not, and to express authoritatively the views of the profession concerning them.

If the Society of American Foresters did these things effectively, it would help immeasurably in finding constructive answers to the two questions—where are we going, and how shall we get there. The role of leadership is not, however, an easy one to play, especially for a small society with widely scattered membership and weak financial support. It requires an organization that will permit the active and continuing participation of the majority (preferably all) of the members in the Society, and most of all it requires a realization on the part of the members of the truth of the adage that the more a man gives the more he receives.

One is tempted to end up with a resolution after all. Doubtless it is better to refrain and to let each reader, if he wishes, frame his own; but with the hope that he will not fail to take whatever action may be called for by an honest answer to the question, "Quo vadis?" —*Journal of Forestry*, Vol. 42, No. 1, dated January 1944.

INDIAN FORESTER

AUGUST, 1944

A NOTE ON CATCHMENT AFFORESTATION IN N. W. INDIA

BY LT.-COL. N. G. PRING, I.F.S.

A career spent mainly in the Himalayas west of the Jumna and a study of catchments in the Alps and Pyrenees forms the background for this essay. Visits to really well-wooded catchments near Darjeeling and around Shillong acted as a stimulus to the writer.

The writer deals particularly with the role of the forest in affording a sustained subterranean water supply which is so important for a region depending largely on irrigation. He stresses the loss of water catchment efficiency through the heavy disforestation of village forests in the catchments of N. W. India and urges that reafforestation be included in post-war reconstruction schemes for all provinces and states concerned.

The three chief means by which woodland contributes towards an increase in water supply are by increasing precipitation, preserving the soil from erosion and the storage of water in the ground.

Much has been written regarding the effect of forest in increasing rainfall but nothing absolutely proven so far as the writer is aware. Proof would indeed require long-term rainfall statistics both before and after the establishment of plantations in a region devoid of woodland. We know that forest has a moderating effect on extremes of temperature. In arid zones swept by a moisture-charged wind, forest would probably increase rainfall locally, particularly on low hills over which saturated atmosphere would pass undischarged if the surface were heated. Perhaps the safest course is to regard the forest as a most favourable factor.

The soil conservation value of forest is incontestible because trees and shrubs not only bind but also hold and increase the soil better than grass or other herbs. Granted that the rate of runoff increases with the degree of erosion, soil conservation must obviously result in water conservation. On hillsides, where gravity is a major factor, the efficiency of well-stocked forest for the purpose of slow storage catchment is unrivalled and it is worthwhile analysing the role of the tree in this respect. The leaves, branches and trunk reduce the force of a downpour and the dripping that continues after rain has stopped prolongs the period of precipitation appreciably. The value of humus as an absorbent is undoubtedly increased by the shade of the canopy which prevents evaporation. Perhaps the most important part in the storing of water is played by the roots, remembering that it is not merely the roots of living trees whose property it is to anchor the tree and also absorb water from the earth, but the decaying or decayed root systems of generations of trees that aid subsoil storage. We know that roots of many species penetrate deeply and that some species penetrate rock. In other words, the root system increases the porosity of the subsoil, thereby ensuring a slow underground flow. This underground supply serves as a constant feed for springs and wells and is, of course, of vital economic importance, being the only source of supply to hundreds of small rivers during periods of drought. These rivers are tapped for local irrigation on an extensive scale and the surplus affords a valuable supply to the snow-fed rivers when the latter are low and every cusec is needed.

The assertion that grasses and other herbaceous flora afford an as efficient catchment cover as trees or shrubs is frequently made; granted that this may be so in certain zones such as Alpine pastures on easy ground or the

downs and wolds of southern England, it is certainly not the case in steep mountainous country with an unevenly distributed rainfall. From really well-tended *ghasnis,* where the grass was cut and not grazed and where the cover was sufficient to prevent erosion, I have several times seen rainwater pouring off over the surface.

When statistics are not available it is permissible to fall back to experience, so perhaps the following observations during the course of frequent tours in the western Himalayas will be acceptable. From some of the streams in the Simla catchment area flow was found to continue when visited after long dry periods whereas at similar altitudes flow in the ravines of disforested catchments ceased altogether during summer and autumn droughts. In the outer hills, at elevation between 4,000 and 6,000 ft., the manner in which perennial springs emanated from oak (*Q. incana*) forest was remarkable, and certainly supports the contention that oak is the tree *par excellence* for catchments. It is certain, therefore, that, in addition to other numerous benefits, forest affords an equable distribution of waterflow which is essential for provinces in the sub tropics dependent on irrigation for their prosperity. Another important feature of forest catchment water-supply lies in the fact that the silt brought down, being light and fertile, is beneficially distributed over the lands irrigated, whereas the coarser soils brought down from disforested catchments tend to silt up canals and channels. The carriage of millions of tons of sand from disforested catchments in the Punjab Siwaliks over the fertile lands below is an example of the terrible harm caused by injudicious disforestation.

Throughout the Punjab, Frontier and Baluchistan, particularly the more arid hill tracts, the abundance of tree growth along *kuhls* (water channels) designed for irrigation or mills, is evident. This is, of course, perfectly understandable, and indeed in Lahoul and parts of Baluchistan, irrigation is necessary to raise tree crops. These add to the underground supply, reduce the runoff and stay erosion during heavy rainfall. In Simla and the lower Kulu Valley the writer has used trenching on a very small scale to raise trees on hot, dry slopes. These trenches, which were about 9 in. by 9 in. and aligned by eye for short distances, were used as temporary traps to catch water and see the seedlings safely into the sapling stage. After a couple of monsoons the trenches had fallen in or silted up, but the trap value remains for several years and the method might be worth trying on a larger scale.

Within the forest the fertility of irregular forest as compared with regular forest is noteworthy. During dry periods the surface of the former retains moisture for a far longer period for which the following is a partial explanation. The root system of an uneven-aged crop utilises the soil to a much greater degree of efficiency than that of an even-aged crop because the latter confines its root system to a uniform soil layer whose depth depends on the age of the crop and, in the earlier canopied stages of an even-aged crop, massed root competition must tend to dry out the soil quickly. It is reasonable to assume that a not-too-severe competition makes for root depth in search of moisture just as healthy crown competition results in height growth through the struggle for light. This may be so up to a point, but whereas daylight is a constant factor, soil moisture is a very variable one. The practical solution is, of course, to prevent overcrowding of crowns and roots by thinning.

In areas of heavy snowfall the writer feels that the advantage lies with irregular forest because snow damage is less and snow accumulates to a much greater depth. In group selection forests one meets with patches of snow outside the older groups but shaded by them long after snow has melted elsewhere. The value of timber belts for preventing snow-slides and snow-melt is very great. In Kulu and elsewhere I have seen snow accumulations along the upper edges of wood-land weeks after snow has melted, in the surrounding areas both within and without the forest. The resultant melt is absorbed wholly by the ground.

In general it may be said that, while group selection type of forest is the ideal from the

catchment point of view on hillsides subject to alternating very wet and dry periods, the main thing is to maintain under properly tended forest an area sufficient to prevent erosion locally. The necessary ratio of forest to agricultural land and grazing ground depends on the physical features of the locality; gradient, rainfall, the siting of woodland, the nature of the soil and the degree of terracing, etc., being dependent factors., In any case it is safe to assert that forest that prevents erosion on a hillside must have a very high catchment storage value.

Of course, the above conclusions in no way ignore the geological factor which plays an enormous part in catchment. A barren dip slope of impervious rock or clay would result in an immediate flush after rainfall ideal for maximum surface catchment; whereas, afforestation of a similar surface besides reducing the rate of runoff, also reduces somewhat the total quantity through soil absorption and subsequent plant transfusion. The percentage loss depends on the quantity and on the nature of the rainfall, that is, a slight drizzle may be wholly absorbed and a greater proportion of light rain over a long period may be absorbed than the same quantity from a heavy shower of short duration. Apart from the porosity of the soil and subsoil, strikes and faults trap precipitation. In many rugged ranges large quantities of rain and snow water are stored underground as evidenced by springs that issue from rock and waterfalls from precipice. It must be remembered though, that however porous the subsoil, grazing tends to harden the top soil and heat to bake it, and therefore on over-grazed slopes, rain runs off the surface without ever getting a chance to soak in.

Past history shows that for a short period between the Sikh War in the Punjab and the founding of the Forest Department, timber traders indulged in heavy unregulated felling, which was however, confined to certain easily accessible valleys or localities in the neighbourhood of hill stations.

During the past three quarters of a century the Forest Department has founded throughout India a magnificent forest estate for perpetuity under systematic management. During the same period in N. W. India huge areas of forest which were not brought under the control of the Forest Department have disappeared. Much of this serious disforestation occurred in the lower hill tracts where pressure of population and the grazing incidence increased at a very rapid rate during the peace that followed the Gurkha and Sikh Wars. The high hills did not escape, and we know that large areas of undemarcated village forest or privately-owned forest in the Punjab and the Frontier covered what are now poor and frequently eroded grazing grounds. Even to-day one can find many instances of woods being exterminated due to overlopping, overgrazing which prevents any chance of regeneration, fires and felling.

Some of the undemarcated forests came under the control of the Forest Department but the majority lay outside its sphere and, even where there was a nominal control through rules, it was extremely difficult to carry out the latter without expert advice. Many warnings concerning the rate at which woods were disappearing and erosion increasing issued from Deputy Commissioners at whose request forest officers were sometimes deputed to report on the situation. Until recently, however, practically no preventative action was taken owing to a lack of the necessary legal and executive power to execute recommendations made. Even in Kulu and Seraj it was practically impossible to prevent clear-felling of private forests on steep ground quite unsuited for cultivation, because the subsequent legal process resulted in a game of shuttle-cock between courts and courts of appeal. Perhaps it will not be out of place to digress for a moment to reflect on the enormity of the pioneering work that confronted forest officers during the early history of the department. Their record of demarcation and settlement, on which efficient management can only be based, was magnificent. A firm foundation consisting of an excellent 4 in. = 1 mile survey (by the Survey Department), demarcation and settlement was laid and this vast virgin estate was soon brought under highly efficient working plan management. When we consider the strength

of the forest cadre, the wide areas each officer had to cover and the state of the communications in those days, it is obvious that they could have had little or no time outside the demarcated forest estate. Afforestation was not, however, neglected and the Pabbi, Simla and the other catchment areas and numerous cantonments were planted up with excellent results. After the Great War, when the superior staff of the Forest Department was heavily increased, it was possible to think seriously of tackling the anti-erosion question.

Apart from official reports on various localities dealing mainly with the Siwaliks, a number of articles appeared in the *Indian Forester* and elsewhere. Response came in due course and rightly enough the toughest job, afforestation of the low hills and adjourned bad lands, was tackled first. From these earlier results evolved the village forest division where plough, pasture and woods combine to form a very much improved estate.

The forest officer of the Conservation Circle had to become something of an agriculturist, to encourage terracing, to demonstrate the benefits of closure and grass-cutting as opposed to unrestricted grazing and, with the aid of Co-operative Societies and Village Uplift, raise the general standard of life in the village. As the result of a few persevering pioneers, great results were achieved in the Punjab and far greater results would have been achieved but for the present war, which not only reduced officer staff but called for an extraordinary effort to supply war demands.

The average D. F. O. in the hills although he had a very full-time programme dealing with his own demarcated estate gained a full knowledge of the neighbouring village lands. Many D. F. Os. were directly concerned with undemarcated forest and, in nearly all high hill divisions, the planting up of the 1921 burns afforded afforestation training. With experience one was able to devote more time to the erosion menace that confronted one in almost every division. Certain salient facts stood out:

First, the grazing problem which made it practically impossible to secure a plantation without fencing.

The grazing included local flocks and herds and also migrant herds. The goat was certainly the worst offender and next, on a much smaller and localized scale, the buffalo herd, but local cattle were frequently sufficient to destroy any reproduction of trees or bushes in village forests. One had to fence in the majority of demarcated compartments situated near villages or along roads, and great deal of time and money was thrown away by endeavouring to apply closure by notification without fencing.

The migratory herds and flocks certainly offer a very difficult problem. Some graziers take regular routes, elsewhere there may be alternate routes from summer to winter pasturage and *vice versa*. In any case the itinerary depends on the season; for instance, one spring the herds using the Hindustan-Tibet Road were held up for weeks owing to deep snow along the Indo-Ganges divide near Narkanda.

On another occasion many *gaddis* caught by a heavy snowstorm on the Rotang Pass suffered severe losses. These *gaddis* are much sought after by villagers for manuring the harvested fields, sheep manure being particularly in demand. One old shepherd I used to meet, who grazed the high pastures of Bashahr State in summer and Bilaspur—Kangra borders in winter, told me that he generally separated his goats and sheep on the way down, spending a month or more by request on village lands in various States between Bashahr and Simla. Naturally he was not averse to some good forest grazing, but he was all in favour of the fence because, as he pointed out, notification of closure was not much use to him or his flocks. Stall feeding for buffaloes and cattle, the reduction of goats in favour of sheep and tethering of local goats would certainly be of the greatest advantage to the forest, but grazing is an economic necessity and the obvious solution is to fence the areas where you wish to raise trees.

The second serious problem was lopping. Lopping rights extended to broad-leaved species in many demarcated forests and in some *ilaqas* it was practised on an economically conservative basis, but elsewhere, and

particularly in Hazara and neighbouring ranges of the Punjab, the broad leaf was being exterminated. Now broad leaf is of the very greatest value not only to right-holders but for silvicultural and fire-protection purposes. Therefore, the obvious solution appears to be as follows:

A—To grow broad leaf to such an extent that the lopping rights in force will not destroy the stock and,

B—To ensure a proper rotational lopping system on the lines already practised by many villages.

Many of the broad-leaved fodder species are valuable for their timber or for firewood and charcoal and their value will continue to increase as communications improve.

The third problem is timber. Villagers residing in the higher hills have nearly all rights to timber free at very low concessional rates.

In the good old days before exploitation for export commenced your villager picked his trees just as a Nova-Scotian would if he wanted a mast or two for his ship. There is no doubt that in Himalayan villages the wastage was great, but that did not really matter because the supply was abundant. With the shrinking of the undemarcated forest, exploitation of demarcated forests (especially under the Shelterwood System) and the increase of population, there is no longer an abundance in many districts and, in some valleys, supply is far below the demand. Many working plans have set aside demarcated areas near villages to meet rightholders' legitimate demands and this has certainly eased the situation in many localities. With increasing population and the necessity for improving the standard of living, including dwelling houses, the demands occasioned by timber rights are unlikely to decrease.

Admittedly there is a tendency to abuse the rights; persons with private forest will sell them and then expect to be given timber from village or Government forests. Settlers not entitled to timber at concessional rates will endeavour to get it, or to obtain it clearly through rightholders. Now look at things from the rightholder's point of view: In order to ensure sufficient wood for the job needed, he is almost bound to over-estimate the timber in the round. Naturally he wants good stuff and he wants trees fairly close to his village if he can get them. He is not necessarily a skilled craftsman and most villagers obtain help from those who are and the latter probably do take something in kind. All said and done, it is better for a village to have a store of wood seasoning for future repairs than to have houses incomplete. Maybe, it would be far better to have skilled carpenters with their own timber yards, who would serve communities but, whatever the supply system, it is essential that village woods that have been cut down be replanted quickly. It stands to reason that you cannot have your cake and eat it, and it does now appear that the granting of timber without guarantee of restocking was a major error. A feasible way of tackling the problem would be to afforest small areas, say about ten acres for the purpose of growing villagers' future requirements. The exact size and number of plots would of course vary with the size of the village and crown lands available, but the best areas from timber should be selected, and every stick will be utilised. These village plantations must be demarcated and grown for the village as high forest not to be regarded as part of the village grazing common on which trees are growing. Along *nullahs* and around landslides copses and spinneys of oak and fodder species might be grown for future fodder and firewood supply. If such a scheme can be incorporated into anti-erosion planning, then the problem of afforestation in the high hills will be simplified.

The writer found that in Kulu, timber distribution of fellings from village forest and sales of private forest took a very large chunk out of the time available for one's normal divisional work. For this reason and for the better management of the village forests, the formation of village forest divisions or ranges is the obvious solution. Such formations would

include compartments or sub-compartments set aside for local demand as well as village forest and waste land. Another advantage of a separate village forest unit lies in the fact that many of the badly-eroded areas are situated at considerable distances from the nearest demarcated forest and it is impossible for D.F.Os. to afford the time for touring these areas regularly.

The time is ripe for a heavy afforestation programme and it seems certain that advantage will be taken under post-war construction schemes to employ ex-soldiers on a vital project that will improve the water supply of N. W. India.

The writer would like to stress the following points:

1. *The Need for Warfare on Goats.*—It is either a case of goats or forests as exemplified by Spain, Greece, Mexico and many other semi-tropical lands.

2. *Proper Fencing.*—Thousands of miles of barbed wire will be available after war so why not make use of it? It is the only sure way of guaranteeing crop and soil protection.

3. *An Oak-planting Campaign.* — The three common species are all excellent catchment trees and are also natural hosts for the conifers of their locality.

4. *The Uniform Use of the 4-in.-1 mile Survey Maps.*—Most of the demarcated forests and their immediate neighbourhood are covered by this edition and it should be well worthwhile getting them reprinted and the survey extended where necessary. The scale of 2-in.-1 mile is much too small and, in many high-hill regions the local revenue maps are not sufficiently reliable. Good mapping means accurate demarcation, and facilitates checking which will save time and dispute in the long run.

5. *Demarcation.*—Lack of demarcation in the case of village forests has certainly contributed towards deforestation. Distinctive systems of demarcation covering communal forests and privately-owned forests seem to be essential.

6. The establishment of central nurseries for the use of villagers.

7. *Education.*—Afforestation on the scale necessary to ensure the catchment efficiency in the hill tracts can only be achieved with the wholehearted co-operation of the local populace. Education is essential to obtain that co-operation. The writer would suggest that tree-planting and woodcraft be included in the curriculum of elementary education. This could be backed up by allotting every school its own demonstration area.

Throughout the N. W. India extensive deforestation in the hills has resulted in severe erosion in many places and a reduction of the subterranean water supply from a catchment covering some thousands of square miles. Erosion and the resultant loss of fertility of agricultural land is only too obvious. Granted that the storage capacity of a catchment is greatly reduced by the removal of forest cover, it follows that deforestation has greatly reduced a most desirable slow source of water supply and increased rapid runoff. This was bound to have had a far-reaching adverse effect on the irrigable areas of the Punjab and neighbouring provinces and states. For this vast agricultural region, which includes the largest irrigation projects in the world, planning must be on the widest scale to include all the catchments, because piecemeal afforestation, however, advantageous locally, is liable to aggravate conditions elsewhere.

Such a plan calls for the co-operation of the administrative authorities of several provinces and numerous Indian states, for the closest liaison between foresters, engineers, agriculturists and other experts and the enthusiastic co-operation of the *paharis.* A co-ordinating directorate would appear to be essential and financial assistance will, one feels, be readily granted by the Central Government for a project of such enormous benefit to India.

FUEL SUPPLIES IN THE UNITED PROVINCES

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1. The following brief history of fuel demands and supplies in the U. P. explains the present situation and the methods adopted to deal with it:

A—Firewood

(*i*) Up to the middle of 1943 no particular difficulty in meeting demands for firewood was experienced. Owing partly to the shortage of coal and partly to increased consumption of firewood it then became evident that special arrangements would have to be made to increase supplies from State forests. At that time forest contractors held large reserves of firewood at forest railway stations and special trains were run to remove these reserves to cities, large towns and military stations. By this means firewood was delivered to consumers in, generally speaking, sufficiently large quantities to meet demands until the end of 1943, when fresh supplies of firewood became available from new production.

(*ii*) The majority of the U. P. forests is served by the metre-gauge O. & T. railway. Much of the traffic on this railway is connected with sugar factories, of which there are about 140 in the U. P., and a large proportion of the railway's rolling stock consists of open-cage trucks used for the carriage of sugarcane to the sugar factories. The sugarcane crushing season usually starts in Decem- and finishes in April. Thus from May to November sugarcane-cage trucks are available for other traffic and many are used for the carriage of firewood during the non-crushing season.

(*iii*) By the end of 1943 reserves of firewood at forest railway stations were practically exhausted, and since then current production has barely kept pace with current demand, except in certain localities.

(*iv*) There are three main stages in the supply of firewood:

(*a*) *Production in the Forest.*—So far, in spite of local shortages of labour, the U. P. has, in 1944, been able to produce adequate supplies of firewood. In some divisions special fellings have been made and production has been encouraged everywhere. Owing to differences in local conditions production has not been even, some divisions having produced less firewood than normal and others considerably more.

(*b*) *Transport from the Forest to Railhead.*—This gives very considerable trouble chiefly owing to the serious shortage of carts. However, with the assistance of motor transport, a satisfactory proportion of firewood has been moved to forest railway stations except in one or two places. Military motor transport has been extensively used in two forest divisions and a fleet of 42 lorries, owned and operated by the U. P. Forest Department, have assisted, in other divisions, in overcoming the cart shortage.

Thus stocks of firewood at railway stations are generally reasonably satisfactory at present.

(*c*) *Transport from Railhead to Final Destinations.*—This is the main problem. All military demands, and demands from about 20 cities have been co-ordinated on monthly programmes of wagon supplies. Thus each military station and each city has a fixed quota of wagons of firewood to be delivered each month on a priority basis. In spite, however, of giving firewood a very high priority, even, in many cases, over timber for defence requirements, it has not been possible to obtain the full quotas of wagons. Generally speaking, only about 60% of wagons asked for have been supplied on the metre-gauge railway, though wagon supplies are generally more satisfactory on broad gauge railways. In several places there have temporarily been serious shortages of firewood, caused solely by shortages of railway wagons. It has been possible to relieve the situation in a

few places by carrying firewood to destination by motor transport.

It is hoped that, during the period May to October 1944, it will be possible to transport large quantities of firewood by special trains to meet military, civil, and factory requirements.

B—Charcoal

(1) Manufacture and transport of charcoal on a scale large enough to meet demands have not been possible owing to local shortages of labour and the general shortage of railway wagons.

Charcoal falls into two categories:

(*a*) *Producer-gas Charcoal.*—The U. P. Government wishes to convert a large number of petrol-driven vehicles to producer gas and asked the Forest Department to produce 200,000 maunds of producer-gas charcoal during the period November 1943 to May 1944. The U. P. Forest Department was able to agree to supply only 80,000 maunds.

(*b*) *Domestic Charcoal.*—During the same period the U. P. Forest Department undertook to supply 1,20,000 maunds of domestic charcoal. This supply is considerably less than the demand, based on actual requirements.

In April 1944, the Inspector-General of Forests issued a questionnaire regarding fuel supplies. The questions asked and the answers to them as far as the U. P. are concerned are as follows:

(*a*) *Is the quantity of firewood and charcoal available adequate to meet the demand?* —Probably adequate quantities can be produced in the forests, in village lands, and from roadside trees but shortage of rail and other transport prevents adequate supplies from reaching all consumers.

(*b*) *What are the rates in a few main towns?*—(*i*) *Firewood.*—The rates given exclude military rates which vary according to special conditions attached to supply contracts. The retail prices for unsplit domestic firewood are:

		Rs. a. p.	
Agra	...	1-4-6	per standard maund
Allahabad	...	1-0-0	„
Benares	...	1-2-0	„
Cawnpore	...	1-3-6	„
Lucknow	...	1-0-0	„
Moradabad	...	1-0-0	„

(*ii*) *Charcoal.*—

Producer-gas Charcoal.—The Western Circle is supplying 50,400 mds. at Rs. 2-4-0 and the Eastern Circle 29,600 mds. at Rs. 1-14-0. This charcoal is supplied to the Industries Department in sealed bags at an average rate of Rs. 2-5-10 per maund. The retail price varies according to local conditions but does not exceed Rs. 2-8-0 per maund.

Domestic Charcoal.—F. O. R. rates at forest railway stations vary from Rs. 1-12-0 to Rs. 2-2-0 per maund supplied loose in wagon-loads.

(*c*) *Is the price controlled and, if so, is it successfully controlled?*—The U. P. Forest Department fixes the prices of firewood and charcoal at forest railway stations. Firewood is thus despatched to cities at fixed prices F. O. R., where it is taken over by the District Magistrates' agents. District Magistrates then fix the retail prices from their city depots, which are controlled. Thus prices of all firewood and charcoal despatched to cities under arrangements made between the Forest Department and District Magistrates are successfully controlled.

Similarly the prices of firewood and charcoal supplied to the military are controlled.

On the other hand quantities so supplied are only a small proportion of actual consumption as much firewood and charcoal is supplied to cities from local resources and is sold at controlled prices or, in common parlance, at black-market rates. It has, however, been found that black-market rates are, to a considerable extent, affected by the controlled rates so that even a comparatively small amount of firewood being made available in a city at a controlled price reduces the black-

market rate considerably. It is not possible to say what proportion of firewood consumed is sold at controlled rates as the necessary data are not available. In one group of cities there was a demand for 2,000 wagons per month to meet civil requirements but a supply of only 850 wagons per month could be arranged. This indicates that considerably less than 50 per cent of demands are met at controlled prices, especially as wagon quotas are rarely worked up to in full.

(*d*) *Is there any rationing scheme, if so how successful is it?*—The shortage of transport makes it necessary to impose a strict rationing scheme. Military demands are accepted only according to actual requirements based on a recently reduced scale of rations of firewood per man per day. Civil demands are made by District Magistrates, scrutinised and, if necessary, revised by the Civil Supplies Department, and accepted only up to the limits of available transport. The U. P. Timber Transport Advisory Committee then arranges monthly programmes of supplies.

As practically all railway stations from where firewood is supplied are controlled by the Forest Department this rationing scheme is very largely successful. Unfortunately the shortage of wagons makes it impossible to work up to this programme nowadays and, generally speaking, only about 60 per cent or 70 per cent of the wagons allotted are actually supplied each month by the railways.

There is also a considerable amount of local rationing in cities, for example in some cities sales of firewood from Government depots are restricted to one maund per person per day. Retail depots in cities may also be rationed by fixed quantities being supplied weekly from wholesale depots.

(*e*) *Is the demand still rising?*—Yes. The rising demand falls into three categories:

(*i*) *Military.*—The numbers of troops in India are increasing and so the demand is increasing. Besides this shortages of firewood elsewhere have increased the demand on the U. P. For example Lahore military district used to get all its firewood from the Punjab and Sind but has now been forced to get a large proportion of its requirements from the U. P.

(*ii*) *Domestic.*—Local resources have been heavily exploited in many places and are becoming exhausted, hence more and more cities and towns are asking to be supplied from reserved forests.

(*iii*) *Factories.*—Owing to expansion of factories and the coal shortage factory demands for firewood tend to increase.

(*f*) *To what extent is firewood replacing steam coal for industry?*—Detailed information on this point is not available. Some sugar factories ued to use coal and have turned over to firewood owing to shortage of coal. Other factories have, in a number of cases, been forced to use firewood as coal became unavailable in sufficient quantities.

It is probable that firewood is replacing steam coal for industry only temporarily and solely because of the shortage of coal. If coal were available it would again replace firewood in such cases.

(*g*) *Who organises distribution? Forest Department, Civil district authorities, or provincial rationing authorities?*—The ultimate authority is the Civil Supplies Department of the U. P. Government. The Forest Department has appointed special officers, at present an Additional Conservator of Forests and two Deputy Conservators, to control fuel and its transport and distribution.

The military and civil district authorities indent for the firewood required. After scrutiny and revision, if necessary, the Forest Department and the Civil Supplies Department working in conjunction with each other, accept the indents and organise the supplies. The Forest Department is then responsible for delivering the firewood to the military stations or the cities where on delivery, it is taken over by the military or civil supply officers. Contractors are largely employed but precautions are taken to ensure that firewood actually reaches military or civil supply depots and is not diverted into the uncontrolled black market.

(*h*) *Miscellaneous information.—*

(*i*) *Prices.*—The general principle is that prices of firewood and charcoal should be kept as low as possible, even to the detriment of the Forest Department revenue. The price of firewood for domestic consumption is a very important item effecting the cost of living. Unless firewood for cooking purposes can be supplied reasonably cheaply the control of food prices at low levels is largely neutralised. The U. P. Forest Department is indirectly subsidising firewood supplies on a considerable scale by making supplies either at a definite loss or by foregoing part of its legitimate royalty.

(*ii*) *Stimulation of Production.*—A start has already been made in some places by allotting a quota of firewood or charcoal to forest sale lots, *i.e.* a standing tree lot is sold on condition that the purchaser supplies a fixed quantity of firewood or charcoal at a fixed price delivered at a certain place. This system is likely to be very largely extended next season. Thus the majority of sale lots in the plains and submontane forests of the U. P. are likely to be auctioned on this system during the 1944 monsoon so as to ensure production of certain known quantities of firewood and charcoal during the period October 1944 to May 1945.

In certain districts a proportion of roadside trees on roads within about a 20-mile radius of cities is being felled to produce firewood and charcoal. This scheme is likely to be considerably extended.

(*iii*) *Future Outlook.*—It is anticipated that it will be extremely difficult, if not impossible, to meet demands for firewood and charcoal during the 12 months commencing in November 1944. Indications are that while production in the Forests and elsewhere may be sufficient to meet demands the shortage of transport, particularly by rail, will prevent adequate deliveries to consumers.

A SIN-ECOLOGICAL STUDY OF THE FORESTS OF MAYURBHANJ

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Mayurbhanj, the largest among the group called the Eastern States lies between 22°—35′ and 21°—17′ North latitude and 85°—45′ and 87°—13′ East longitude, and is bounded on the north by the Midnapore and Singbhum districts, on the east by the Midnapore and Balasore districts, on the south by the feudatory states of Nilgiri and Keonjhar and the district of Balasore and on the west by the feudatory state of Keonjhar and the district of Singbhum. The total area of the state is 4,243 sq. miles, more than one-third of which is covered by forest growth. The central tract of the state—an area of over 1,000 sq. miles—is occupied by hills forming a series of parallel ridges striking almost N.E. to S.W., the elevation varying from 1,200 to 3,824 feet and most of the ridges being above 2,000 feet.

Speaking generally, the state lies within the track of the S.W. monsoon. There are three distinct seasons: The monsoon extending from July to September, the cold season from October to the end of February and the summer from March to June. The rainfall varies slightly from place to place but the average is well over 70 inches a year. Although the state does not receive the benefits of the retreating monsoon, a few good showers are usually obtained during January, February and early March. Frost is not severe and is confined to a small locality above an elevation of 2,500 feet. The summer is prolonged and very dry, the thermometer often registering a temperature of 110° in the shade, even at elevations of 2,000 feet.

The hill tract on the whole is well-watered. Apart from the principal rivers of the state such as the Burabalong, the Palpala, the Khairi and Bhandan, the Salandi, the Kharkhai and the Deo, which take their origin from the hills, there are innumerable perennial streams and small *nallahs.*

The main geological formations of the state belong to the Archean age and come under the Dharwar system, the more prominent being the iron-ore series. This is very well represented throughout the state and comprises a considerable variety of petrological types the chief of which are shales, phyllites and schists, iron ores, basic igneous rocks, laterite and calcareous deposits.

Shales are seen both above and below the iron-ore belts and are much metamorphosed. Their colour is usually buff and on weathering yield an impermeable clay which is generally speaking very unfertile. But where it is mixed with a fair quantity of weathered laterite the conditions seem to be very favourable to the growth of trees, especially *sal.* The basic phyllites are met with usually along ridges and weather readily forming dark coloured soils which support a good growth of mixed forests with varying proportions of *sal.* It is generally seen that if these parts are watered and drained by a perennial stream, *sal* very often grows to an enormous size. Laterite is found all over the state and by itself is very unfertile, but when mixed with a fair proportion of basic phyllites, shales or gneiss it encourages a good forest growth especially on the more favourable northerly and westerly aspects. Calcareous deposits known locally as 'ghooting' are seen only in certain isolated localities and the forest growths in these areas are on the whole very poor.

In general, the forests of the state come under 'the moist deciduous type,' the prevailing type of vegetation being the *sal* forest which represents the natural climatic climax. The locality factors are so favourable to this species that the area—taking the hilly tract as a whole—may be considered as a place where optimum conditions for the growth of *sal* are obtained. *Sal* is found growing gregariously over very large areas and aspect seems to be the most deciding factor in the distribution of the pure *sal* forest type and invariably the forests on the north and north-westerly aspects

are seen to be of a much better quality than on the drier south and south-easterly aspects. Almost all the ridges are bare and formed by large outcrops and dykes of quartzite and phyllite and in going up a slope one can notice the quality and the proportion of *sal* slowly diminishing until an elevation of 3,000 feet is reached when the crop changes all at once to a mixed type with a low percentage of stunted and stagheaded *sal*.

In certain areas where the soil, aspect and other factors are extremely favourable to the growth of *sal*, frost seems to inhibit the growth and development of the tree and in these parts even at lower elevations the crop is open, often stagheaded before they reach maturity and the average tree seldom attains a height of 70 ft. and girth of 6 ft.

Although there is very little difference in the soil from place to place, the *sal* forest can be divided into two quality classes, taking the height growth of the pole crop (trees up to 4 ft. in girth) as the criterion. In the 'quality I *sal* forest' the average height of the pole crop is about 60 ft. while mature trees often grow up to 100 ft. and attain a girth of 10 ft. This type predominates over all other types of vegetation in areas where they are found and covers about two-thirds the area of the hills. Here *sal* forms about 80 to 90 per cent. of the growing stock, and their general conditions of growth are good. Natural regeneration on the whole is not satisfactory, and is seen in patches, although the factors are all extremely favourable. Every year there are extensive ground fires in these areas, followed by sheet erosion and the absence of regeneration may be attributed to the above causes. Unlike other parts of India where the natural regeneration of *sal* has become a problem, in Mayurbhanj it is seen that in almost all fire protected areas the forest floor is practically covered with *sal* seedlings in August or September.

The common associates of *sal* in the above type of forest are *Terminalia tomentosa, Anogeissus latifolia, Adina cordifolia, Xylia xylocarpa, Schleichera trijuga, Burserra serrata* and rarely *Dalbergia latifolia* and *Albizzia lebbek*. The undergrowth is usually dense and consists of *Corton oblongifolius, Cleistanthes collinus, Emblica officinalis, Nyctanthes arbortristis, Alangium Lamarkii, Randia dumetorum, Kydia calycina, Mallotus philiphinensis, Flemingia chappar* and *Wendlandia* spp. Climbers are common, though not in great abundance the usual ones met with being *Bauhinia vahlii, Combretum decandrum, Milletia auriculata, Smilax macrophylla, Butea superba, Clematis* spp. and *Dioscorea* spp. Grass is very rarely seen in lower elevations but above 2,000 ft. it is very common. Generally four species are met with: *Imperata, Saccharum montana, S. munja* and rarely *Pollinidium angustifolium*.

In the 'quality II *sal* forest' the canopy is partly open and the pole crops show an average height growth of 40 ft. while mature trees rarely reach a height of 70 ft. and girth of 6 ft. This type is found mostly in the south and south-easterly aspects and in these areas there is a marked tendency for *sal* to give place to such miscellaneous species as *Xylia xylocarpa, Terminalia tomentosa* and *Anogeissus latifolia*. In this type of forest the percentage of *sal* varies from 40 to 60 and the associates are usually *Pterocarpus marsupium, Xylia xylocarpa, Terminalia tomentosa Adina cordifolia, Mitragyna parviflora, Terminalia chebula, T. belerica* and *Bridelia retusa*. Almost always there is a thick undergrowth of shrubs such as *Cleistanthes collinus, Croton oblongifolius, Nyctanthes arbortristis, Emblica officinalis, Lea sambucina, Wendlandia* spp., *Flemingia chappar, Randia dumatorum, Indigoferra pulchella, Colebrookia* spp. and climbers such as *Bauhinia vahlii, Butea superba, Zizyphus* spp., *Combretum decandrum, Spathalobus roxburghii* and *Dioscorea* spp. A dense growth of grass—*Imperata* and *Saccharum*—along with the palm *Phœnix aucalis* is seen at higher elevations. This dense undergrowth together with the devastating annual ground fires very greatly diminish the chances of *sal* regaining its lost ground. Regeneration of *sal* on the whole is very poor and the few seedlings that come up after the monsoon are either suppressed by the weed growth or killed by the ground fires in the following year.

A third type: the 'mixed deciduous forest,' covers a fairly large area of the hills and this is slowly extending itself into the pure *sal* forest mainly due to the exploitation of *sal* to the total exclusion of all other species and also fire. Moreover, *sal* does not seem to tolerate epidiorite especially on the south and south-easterly aspects and in these parts the crop met with is a typical mixed deciduous type where *sal* often forms less than 25 per cent. About 40 species of trees are seen in this forest, the more common and valuable among them being *Xylia xylocarpa, Anogeissus latifolia, Terminalia tomentosa, T. chebula, T. belerica, Adina cordifolia, Burserra serrata, Dalbergia latifolia, Gmelina arborea, Bombax malabaricum, Mitragyna parviflora, Lagerstrœmia parviflora* and *Schrebera switenioides.* Along the banks of perennial streams and *nallahs, Michelia champaka, Hymenodiction excelsum, Anthocephalus kadamba, Trewia nudiflora, Terminalia arjuna* and *Salix tetrasperma* are also met with.

Two distinct associations are seen in this type of forest: the *Xylia—Anogeissus* association and the *Terminalia tomentosa—Adina cordifolia* association, the former in the more dry parts where the soil is distinctly of a poor quality and the latter in parts where water is available—along streams, *nallahs*, etc. The percentage of distribution of the various species is approximately as follows: *Anogeissus latifolia* 20 per cent., *Xylia xylocarpa* 15 per cent., *Terminalia tomentosa* 10 per cent., *Adina cordifolia* 5 per cent. and the rest all species including *sal*. This distribution, however, shows some variation from block to block and in some parts the proportion of *sal* to the other species is almost 1 in 10.

There is a dense lower canopy formed by such shrubs as *Cleistanthus collinus, Alangium lamarkii, Buchanania latifolia, Randia dumatorum, Indigoferra pulchella, Wendlandia* spp., and *Colebrookia* spp., while there is a profusion of climbers, the most common being *Combretum decandrum,* and *Milletia auriculata.* Higher up the slopes grass—mainly *Imperata*—and *Dendrocalamus strictus* are seen, although the growth of the latter is not good.

Regeneration of *sal* is almost totally absent while that of *Xylia* and some parts *Dalbergia latifolia* are fairly good, but the seedlings of the other valuable species are suppressed by the thick weed growth. The competition and struggle for existence in the type of forest is so great that the few *sal* seedlings that germinate on the floor, never get a chance to come up and are suppressed and outgrown by the more hardy and fast growing species such as *Adina cordifolia, Xylia xylocarpa* and *Terminalia tomentosa.* Moreover, as grass is found in more or less the whole area occupied by this type of forest, fire causes the greatest damage and it is one of the most important reasons for the gradual deterioration of the existing sal crop and also the absence of *sal* regeneration.

The following conclusions have been reached by a close study of the locality factors and general conditions available in Mayurbhanj:

(1) *Sal* seems to grow well in a heavy but well-drained soil derived from acid rocks. Iron is definitely beneficial as the purest *sal* crops are invariably found in places where iron ore predominates. The best development of *sal* is seen in such places especially if water is available at the spot.

(2) *Sal* totally avoids epidiorite with a shallow soil covering particularly on the drier south and south-east aspects.

(3) Regeneration of *sal* is very easy provided the required locality factors are favourable and fire checked until the seedlings reach the sapling stage.

EXTRACTS

SCIENTIFIC AND INDUSTRIAL RESEARCH IN GREAT BRITAIN

The uniformity with which recent reports on scientific and industrial research have insisted that provision for scientific research in Britain was dangerously small before the outbreak of the present war has been taken in some quarters as a disparagement of British achievements. Only the most desultory reading of the reports in question could afford any support for that contention; on the contrary, there is general agreement as to the ability of scientific men in Great Britain and the merits of their achievements, as emphatically as there is agreement that the *per capita* appropriation in Great Britain, both for industrial and for public research, has been far below that in the United States of America and the U.S.S.R. It was a disappointing feature of the report of the Larke Committee on Industry and Research that it provided such meagre information under this head, but there can be no doubt that, had such information been incorporated in that report, it would have corroborated the evidence submitted by the Parliamentary and Scientific Committee.

In a particular field it is well illustrated by the report on methods of building in the United States recently issued by the Ministry of Works. This report of a mission appointed by the Minister of Works in July 1943 shows that the building industry in the United States is considerably ahead of that in Great Britain, not so much in the quality or organization of its research as in the scale on which it is prosecuted, the use made of scientific personnel in the industry

and effectiveness with which the results of research are disseminated. There is no doubt as to the appreciation in the United States of the results of British research and of some features of its organization, such as the Building Research Station. None the less, the main burden of this report is similar to that of all the more important recent general reports: more generous endowment and vigorous prosecution of research, the wider employment of scientific personnel at all stages in industry, and more effective means to secure that the results of research are made known in ways that facilitate their utilization in industry. A further special illustration is to be found in Dr. F. King's recent paper on "Petroleum Refining—A Chemical Industry", read on February 4 before the Society of Chemical Industry, when he powerfully urged the importance of expanding the petroleum refining industry in Great Britain by an adequate research and development policy, so as to provide the basic raw materials for a new chemical industry in the manufacture of solvents, plastics and fibres.

This neglect of new discovery was one of the main reasons for the relative decline in British technical efficiency in the inter-war period, and there is little, if any, dissent from the view that it is essential to remedy this position so that the country may be able to hold its own after the war in the general technical progress. There is now general agreement as to the necessity for a marked expansion in the scope of technical and natural scientific research at the universities and other public institutions, as well as in the facilities for training scientific personnel for such work and for industrial research, and probably also that such expansion should be achieved by a suitable increase of the Parliamentary Votes for the purpose: but there is as yet some uncertainty as to how best research shoud be stimulated in industry itself.

That is one reason behind the controversy at present proceeding as to the suitability of the patent law system of Great Britain under present conditions and the question of compulsory licensing. The question was raised broadly by Dr. P. Dunsheath in his Atkinson Memorial Lecture and, apart from the suggestion that the present system does not really encourage research and development, the discussion has been linked up, on one hand with the wider question of the control of industry by the State, and on the other with the question of the manner in which the State should encourage research by the remission of taxation. The way in which this question is related to that of obsolescence was well put in an article in *The Round Table,* and superficial discussion may easily tend to blame the patent law system or industry itself for shortcomings which are due primarily to an archaic taxation system, out of harmony with the facts and requirements of modern life. The question whether the State should support, without further regulation, research carried on by private firms, either directly by subsidies or tax remission or indirectly by placing at the disposal of industry the facilities of, or results obtained by, public research institutions, has been examined by Dr. T. Balogh in an article in the *Bulletin of the Institute of Statistics,* Oxford. This illustrates the theoretical character of some of the discussions of this subject from the economic point of view. It may be generally conceded that the State's duty in the encouragement of research and development is primarily to foster self-help, under fair conditions, and not in the main to do the job itself; to favour enterprise of the right kind; and to lend public aid where private effort is insufficient. That the imperative task of research is not to maintain particular industries in a particular state of employment or profits, but to increase the national income, even at the cost of very radical adjustments in the structure of industry and employment, and in the use which is made of the nation's total resources, is much more likely to be challenged from the scientific and technical side of industry.

Dr. Balogh follows Dr. C. G. Paterson in arguing that modern development has changed the whole technical and economic back-

ground of the patent law system of Great Britain, and that this has not been explicitly recognized either by a reorganization of scientific research or by patent law. He concludes tentatively against subsidies to private investment in plant of existing types without adequate safeguards. While research into new methods or products may be stimulated in this way, as the new and more efficient methods resulting lead to a potential increase in the national real income and in the international competitive capacity of the country, the danger remains that the effectiveness of the new discovery will be either sterilized or used for the undue purpose of monopoly gains. Measures must, he urges, be taken to safeguard the interests of the community and against retardation of progress.

Dr. Balogh has thus really established the case for reform of the principles of inland revenue, but he goes on to expound the view that, as matters stand in Britain, the State must assume the main burden of increased research, and in the main the expansion of research should be undertaken by the universities or other public institutions. He appears to have in mind particularly the establishment of technical institutions on the lines of the Massachusetts Institute of Technology or of the Continental high schools; but since he suggests that the results of such research should be available on a licence basis to industry, presumably he does not favour a policy of full publication. Stimulus to public and private research in conditions which exclude a misdirection and misuse of the results should, in Dr. Balogh's opinion, be one of the main tasks of reconstruction, but his suggestions are likely to bring him under heavy fire from both the industrial and the scientific sides if they are seriously pressed.

The report on scientific industrial research which has been issued by the London Chamber of Commerce* may well be open to a similar type of criticism, at least as regards its chief new proposal for a central research board, both on the grounds of the practicability of finding the type of personnel necessary, and on the desirability or feasibility of the kind of direct control suggested. Much of the report, it is true, is not new. Reiterating that while the inventive genius and scientific knowledge of Great Britain are second to none, financial policy has put us behind others in adequate provision of equipment for research, facilities for scientific and technical instruction, and such reward to successful men of science as would ensure a sufficient supply of men of the first quality, the London Chamber of Commerce concludes that there are three essentials to stimulate research into full and fruitful activity.

Of these three essentials, two are in line with the recommendations of earlier reports, namely, a far greater stream of money flowing into research, and a larger, better trained and better paid personnel. The third, and foremost, is new, namely, centralized and planned direction through a central research board. This proposal has something in common with Lord Samuel's subsequent suggestion at the annual luncheon of the Parliamentary and Scientific Committee that the Lord President of the Council should exercise the functions of Minister of Science in the Cabinet.

Lord Samuel's suggestion is admittedly vague and might not in fact amount to much more than Dr. Dunsheath's proposal for a central co-ordinating secretariat and information service. The London Chamber of Commerce bases its proposal on the view that the support which has been forthcoming both from industry and from the Government for the fundamental type of research carried out by the research associations in Great Britain is insufficient to ensure either in quality or quantity the necessary measure of success An attempt is made in the report to distinguish between 'fundamental' research and 'pure' research, aimed at the increase of natural knowledge for the sake of increasing knowledge and not for any particular industrial objective. The latter type of research, which in practice is hard to differentiate from long-range research on major technical problems, is regarded as an enterprise which should be

* Report of the London Chamber of Commerce on Scientific Industrial Research. Pp. 16. (London: 69 Cannon Street, 1944).

financed by the nation, and should be carried on in the universities, though the desirability of close relations between industry and the universities in fundamental research, whether prosecuted in industry or at the universities, is recognised and welcomed.

The main purpose of the London Chamber of Commerce in urging the creation of a central research board to act as a co-ordinating and directing body for all research organizations and to form a link between the Government and the research activities of the country at large is to strengthen the present cohesion of our structure of research. The Advisory Council of the Department of Scientific and Industrial Research is not constituted, nor would its present terms of reference enable it to act, in the way and for the purposes now envisaged. A central research board, for example, should have as a primary function the encouragement of private firms to make available to industry at large, through the board, those discoveries which they did not feel it necessary to retain for their exclusive use. The board should accordingly be empowered to make grants, free of income-tax, to private firms for such discoveries as are surrendered to the board, and these payments would be designed to encourage firms to complete lines of investigation which they might otherwise abandon as too remote from the problems of their own industries.

A second function of the proposed central research board would be to ensure that adequate facilities are available in every research association for private work, under conditions which would create confidence, on behalf of small firms. It is also proposed that the board should have the right to intervene and acquire research associations, in consideration of the public funds placed at their disposal, to undertake fundamental research in directions which it judges to be in the national interest, and to require greater activity on the part of those research associations which, in the opinion of the board, are proving unequal to their responsibilities. It should be the further duty of the board to consider the effect upon trade and industry as a whole of discoveries of a fundamental nature, and to direct the use of those discoveries so that they may be of the maximum advantage to the nation.

The duties of the board would not end here. With regard to the fundamental research carried on in the universities, the board would have the function of ensuring that the results of such research would be applied in the shortest possible time. Scientific men in particular may well begin to wonder what manner of men they may be who will constitute the board, and they will be glad to learn that a highly qualified secretariat is recommended to assist in handling the complex problems involved. Again, it is suggested, that the Board of Trade or the Department of Overseas Trade should place before the central research board any facts bearing upon the loss of markets by British products, at home or abroad, due to poor quality or high price, and the board should take up the matter with the research associations and with individual firms.

Within its charter a central research board should have the same freedom of action as the British Broadcasting Corporation, under the aegis of, and presumably responsible to, the Lord President of the Council. Five industrialists, with practical experience, four men of science, and three representatives of labour, with a whole-time highly salaried chairman, and the full-time, expert secretariat already mentioned, are suggested as constituting such a board. Alternatively, the Council of the Department of Scientific and Industrial Research might be reconstituted on similar lines and its terms of reference widened to permit it to discharge the functions proposed. The present functions of the Advisory Council for Scientific and Industrial Research might then be discharged by a committee of the board. Finally, the question is raised for consideration whether a central research board should delegate its functions concerned with the universities to the University Grants Committee, or to a separate body concerned with research only, leaving the University Grants Committee to continue to function as at present with regard to all funds not specifically earmarked for research.

With regard to finance, the report considers that the universities should maintain a far

larger staff than at present of graduates and of skilled laboratory technicians, and recommends a substantial increase in the number of research fellowships at the universities. The whole of the present annual Treasury grant to the universities would be quite inadequate to enable them to carry on the research which the London Chamber of Commerce regards as essential: indeed it strongly supports the Parliamentary and Scientific Committee in its recommendation that a sum of £10,000,000 should be spent over the first five post-war years in equipping and enlarging the university laboratories, apart from carrying out the expansion of the technical and art colleges on a programme estimated before the War to cost £12,000,000. The report urges, however, that all applications for research grants should come to the proposed central research board and be made by it to the Government, and that similarly all grants made by the Government should pass through its hands.

With regard to the research associations, the report advocates a compulsory levy, where necessary, on each industry for which a research association is thought appropriate. Again, the report is in agreement with the view of the Federation of British Industries that all expenditure on research and development should be chargeable against revenue, either immediately or over the commercial life of any asset created. It also urges that the cost of pilot plant, as well as of laboratory buildings and equipment, should be chargeable against revenue.

The London Chamber of Commerce is impressed with the need for attracting to a scientific career a larger percentage than at present of men with first-class brains, and urges the up-grading of salaries offered to scientific men in industry, the research associations and the universities... Reference is also made to the importance of technical education and of much more generous endowment of the technical colleges; while finally, the importance of publicity is stressed. Individual undertakings must be made more research conscious, including employers, shareholders and workers alike. The report expresses the belief that there are resources of inventiveness and ingenuity among the people of Great Britain generally which skilful propaganda could assist in tapping.

In the main, the London Chamber of Commerce has merely restated the arguments for the expansion of our research effort on lines urged by the Federation of British Industries, the Parliamentary and Scientific Committee, and other bodies and individuals, with the specific exception of its proposal for a central research board. On this proposal two main comments may be made: first, the organization indicated may prove too rigid and demand too much of the individuals constituting the board, which scarcely seems to fit the machinery of government: and secondly, there is no apparent provision for seeing that research is prosecuted in the biological and social sciences in comparison with the physical sciences to the extent required to maintain a better balance in the advancing front of science. That there is need of some further measure of co-ordination of our research effort is scarcely questioned; but the manner in which that can best be planned or controlled without detriment to the internal discipline or freedom of science is a matter for serious discussion.

Here the report does well to raise the question of the adequacy of the University Grants Committee in regard to research purposes as was done in the report of the Parliamentary and Scientific Committee. The question is also discussed in a recent memorandum on "The Development of Science" issued by the Association of Scientific Workers, which suggests that to assure adequate financial resources for fundamental scientific research and the wise use of those increased resources, a university council, reporting, for example, to the Lord President of the Council, like the Scientific Advisory Committee, should be formed to extend the functions of the University Grants Committee. It should be competent to discuss in detail all questions of university policy and, without impairing the independence of the individual universities, it would provide a democratic machinery by which the universities as a whole could take the guidance of their future into their own

hands, and the Association suggests that a body of the type indicated in the memorandum should achieve a greatly increased measure of self-government of university science by university men of science.

By and large, the stimulation and endowment of fundamental research on an adequate scale is the first and main problem. Opinion may well be reserved as to how far, or how soon, the creation of a university council of the type suggested is likely to proceed without some external stimulus or some far-reaching university reforms; and if university co-operation has not been particularly marked in the past, the capacity of scientific workers to co-operate even within a limited field of science has not been so successful that the prospect of increased self-government will make any pronounced appeal to them or to the community. The first step may well have to be taken by the Government, following the lead given by some such body as the Parliamentary and Scientific Committee. The adequate endowment and prosecution of industrial research should follow from such steps, once fundamental research has been adequately planned and endowed, and given right relations between the State and industry. The discussions which are already proceedings to the mechanism of State control, the relations between enterprise and planning, between taxation policy and the encouragement of development and research, and between patent law and industrial research are all to be welcomed as contributing to this end. If such discussions can be kept clear of faction or prejudice, and pressed home to lay bare the fundamental issues they can do much to indicate the right lines on which the organization of research should proceed in Great Britain. They will suggest conditions likely to stimulate creative thought and invention, and also ensure, not merely that the maximum social use is made of advancing scientific knowledge, but also that adequate effort is concentrated in those fields where social needs, instead of financial or other sectional interests, show it is likely to yield the maximum advantage to the community—*Nature*, Vol. 153, No. 3880, dated March 11, 1941.

BANDED MONGOOSES AS PETS

By Arthur Loveridge,

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Mention a mongoose and nine times out of ten the conversation will drift to cobras, so intimately are the two associated in the minds of most people as a result of the activities of an Indian species. Yet of the 21 different forms of mongoose which I have collected in East Africa, few indeed showed any partiality for snakes most of them being about as omnivorous as their North American relatives--the skunks.

Among them the banded mongoose is of outstanding interest by reason of its gregarious nature, which finds expression in communal hunting and results in this species readily accepting human companionship when offered it at an early age. As a species the banded mongoose ranges right across Africa from Portuguese Guinea in the west to Eritrea in the east and southwards throughout the great continent in all suitable regions that are free of forests.

My first acquaintance with the African form (*Mungos mungo colonus*) was at Morogore in central Tanganyika Territory. There, when returning to my quatrers one wet evening after a torrential downpour which had left the roads half-flooded, I noticed a dozen soldiers watching some small object in the road. It was a mongoose kitten, looking very forlorn and from time to time uttering a shrill cry. The little creature was just over a foot in length from end of nose to the tip of its somewhat stumpy tail, its fur a very dark brown. Presumably it had been washed out of a drain

or some other retreat by the heavy rain. It ran well, and when covered with a towel attempted to bite through it. After carrying it to the factory in which I was bivouacked at that time, I provided it with milk, raw liver, and boiled meat, but it touched only the milk and in that it lay down!

All the time it maintained a monotonous whistle, not unlike a single note of a canary's song. The immediate effect of its cries was to elicit an answering call from a stray cat that had established itself downstairs, such a call as any puss might use when answering her kitten. Presently the cat appeared through a belt hole in the floor and approaching the box with considerable caution, stood upon her hind legs and viewed the prisoner through the wire netting. It was quite amusing to watch the reactions of both.

But it was a few months later that I really came to know these mongooses. I was camping on the lower slopes of the Uluguru Mountains, and my Mkami assistant, Salimu bin Asmani, brought me word that he had seen two young banded mongooses in a near-by village. Their owner, a lad of his own age, was quite willing to sell them, he added. I sent him back with the necessary cash, and the little animals, keeping to heel in a most surprising way, followed him home through the bush for a distance of fully a quarter of a mile. In build they struck me as being rather otter-like, though in size they were but little larger than big rats. At this stage the score of rufous, black, and dirty white crossbands, so characteristic of the adult, were scarcely discernible, so that at first glance they appeared almost uniformly dark brown.

When introduced to my monkey Kima, they sat up on their hind legs with their short forepaws drooping over their little paunches, meerkat-fashion; then they spat explosively and pretended to bite. Though so small, they were well able to look after themselves, spending much of their time rooting about, turning over stones, or digging for insects with their strong claws. They fought over titbits in rather quarrelsome fashion while, except when fully fed, they kept up a continual birdlike cheeping and chirping.

But it was their method of dealing with eggs that made them a source of amusement to my friends. If given an egg, these little mongooses evinced the greatest excitement as they rolled it along towards the nearest wall or other solid object. One of them would seize the egg in its forepaws and, clutching it to its chest as it rose upright on its hind legs, would waddle still closer towards the wall, to which it suddenly turned its back. Then, straddling its legs wide apart, it would fling the egg between them at the wall and spring around with a great display of eagerness to set about devouring the contents if the shell was broken. I discovered that a cockle shell was just as effective and much less expensive for such displays, for, though they never succeeded in breaking it, the mongooses went through the same routine as for an egg. Instead of being discouraged, the futility of their efforts served only to increase their eagerness, which became almost unbalanced in the intensity with which they vied with each other in violent attempts to smash the mollusk. Between times they would fight desperately for possession of the shell, though often, after gaining it, the possessor would fear to fling it lest his waiting relative should filch it. This distrust led to much unnecessary waddling about for position.

One day a dead spitting cobra was brought to me; it had been killed in the act of swallowing a baby chick. I cut off its head to prevent an accident with the poison teeth then presented the body to the kittens to see what they would do. It was probably the first snake that they had ever seen. They approached it with the greatest caution and sprang back again and again, apparently with the object of "drawing it" if alive. As they repeated the manœuvre the bristly coarse hairs of their tails stood on end. In time, finding that the snake made no response, the mongooses accumulated sufficient courage to attack its tail, biting and worrying it, then dashing away till, tiring of play, they gorged upon the entrails. After such a meal their small paunches were very rounded, and they might be seen slumbering in the sunshine, frequently at the foot of the

monkey's pole, for Kima and they soon became fast friends. In fact, during lazy moments, which occurred only when gorged, they would sprawl on their backs and let the monkey inspect their fur most minutely. Except when travelling, the little carnivores were never caged, and taking full advantage of their freedom, on most mornings they would depart for the neighbouring bush on foraging expeditions of several hours' duration.

Once, after a tiring march that had begun long before dawn, I was resting on the outskirts of Tabora when I noticed eight banded mongooses in all manner of indolent attitudes, sunning themselves within 20 feet of a main road along which a noisy stream of natives was passing, the time being about 7 a.m. My porters, having dropped their loads, were moving about gathering firewood within 50 feet of the little beasts, which took not the slightest notice of them.

Another time at Pooma, near Singida, I saw ten banded mongooses sitting erect on a termite hill, intently watching a flock of guinea-fowl which were feeding towards them across the open, the nearest bird being only 20 feet away. So preoccupied were they that I was able to shoot two which were sitting close together, but one fell down a hole in the termitarium. The other proved to be a very light sandy, or straw colour, excellently adapted to life in such arid thornbush steppe. On showing it to Salimu, he declared that the variety was well known to him and that probably all of those in that thornbush country would be of similar bleached appearance.

Unfortunately for this theory, when we dug out its dead companion next morning, it was found to be the typical nut-brown hue —a grizzled brown animal banded on the hinder part of the body with dirty white or reddish white, and black. In length the head and body measured sixteen inches and the tail as much as a foot, though it is unusual for the latter to exceed eight inches.

Sometimes a score of the animals form a hunting party and keep in touch with one another by their continual chirping cries. Meanwhile they turn every stick and stone, running together when one mongoose, discovering something out of the usual, betrays the fact by a different call. Examination was made of the stomachs of all mongooses shot for preservation. One held three lizards, two of which were skinks and the third a rare amphisbaenid (*Geocalamus modestus*) of which three types taken 40 years before were the only examples known. Another had eaten a grasshopper, a large carabid, and the larvae of a beetle. One Morogoro mongoose had consumed three frogs, two centipedes, four slugs, a carabid beetle, cockchafers, cockroaches, locusts, grasshoppers, and a large spider. The stomachs of these animals are relatively large, and the variety of their menu gives some idea of their omnivorous diet. Incidentally, it serves to show how useful a pack must be in keeping down many undesirable agricultural pests, for the quantity consumed by such a pack in the course of a single day must be enormous.

In captivity I fed them chopped meat, eggs, milk, and water as staples, but when possible it is better to give them complete liberty so that they may contribute to their own support by a more varied diet. As already indicated, snakes did not play an important part in the lives of these African mongooses, but whenever one of the animals saw one, his interest was aroused and he displayed excessive caution. Even when a common and harmless species like the brown house snake (*Boædon lineatus lineatus*) was liberated in the open, an adult mongoose treated it with the greatest respect, running after it to bite the tail, then springing back before the snake had time to strike.

When four of these mongooses were brought to me full grown, I confined them in a cage. One-fourth of the front, instead of being wire netting, was a wooden door which slid up and down in a groove. The mongooses soon discovered that they could raise it slightly by pressing their noses against it. Apparently a second mongoose was required to slip its claws into the aperture and raise the door still further before one could get out, so it is doubtful if a solitary animal

could have escaped. As it was, all of them escaped a great many times, chiefly due to the carelessness of their native attendant in failing to fasten the catch which secured the door. It seemed as if the mongooses tested the door each time he opened it to put in food or clean out the cage; at least they never seemed to lose an opportunity of which they could take advantage. With the exception of one animal which escaped permanently, none of the truants went far. They usually retired behind the cage and remained there until discovered, whereupon a wild chase round the room invariably resulted in recapture.

Constant travelling is not good for small creatures and makes it difficult to gain their affection. I recall three mongoose kittens that were brought to me in mid-June when I was camping on Ukerewe Island in Lake Victoria. They were from different litters, for one was much smaller than the other two. Strangely enough one of the latter, though only just caught, dissociated itself from its companions and exhibited an astonishing preference for human society almost from the very first. This threw the other two animals together, for they were bullied by the friendly one, whom we will call A. At feeding times it was customary for A, the strongest of the three, to snap at B and C and drive them from the dish until he had fed to repletion. Should any one attempt to stroke B or C when A was in the vicinity, he would hurl himself upon the recipient of caresses most viciously. If the lid of their large and roomy travelling cage was lifted, A would leap and squeak or chirp for he loved to be taken up and patted, to have his ears and armpits rubbed, or his fur stroked backwards or forwards. He might be rolled upon his back, pulled about by the tail, or dragged along by a leg; no indignity could surprise him into an exhibition of bad temper so far as human beings were concerned.

A fortnight after receiving these mongooses I was camping at Entebbe, Uganda, and allowed them to roam at large—the drop door of their cage being propped up so that they might run back in if alarmed. At Jinja also they were given their liberty for several hours each day. But one could not handle B or C, for they would utter an explosive cry and spring forward with a snap. One good bite upon my finger tip taught me caution so, instead of lifting them back into their cage, I "shepherded them" home when it was desirable to fasten them up for the night.

Before they could again be allowed any liberty, there followed a week of travelling, which included 800 miles by rail. On board ship their cage was placed on the forward hatch, shaded when necessary, and A was allowed out daily. At first the cage was often surrounded by passengers, whose sudden movements proved a source of great alarm to B and C. There were, however, three small boys on board who helped tremendously by playing with the liberated one for hours at a time. After four days at sea, C was gingerly lifted out. She raced about in enjoyment of such freedom until she was scared by the wind blowing a hat along the deck and fled off the hatchway. I was fetched and after a little manœuvring succeeded in retrieving her. On the morning of the eighth day at sea I lifted out the two tame animals, but as B snapped each time I approached him, I desisted after two attempts. Later in the day I returned and, sitting down beside the cage, tried to rub his ears. To my astonishment he crouched down and, though evidently in great alarm, submitted. After petting him for several minutes I quietly lifted him out of the cage and set him down outside: this was almost the last time he gave me any trouble.

The trio raced about the hatchway, stretched out in the sun, or rolled over and over as they bit each other in sham fighting. Two coils of wire hawser were selected by them as their headquarters, serving as refuge from both friends and fancied foes. In due course they arrived at their destination and were presented to the Zoological Society of London.—*Natural History*, Volume LIII, No. 2, dated February, 1944.

INDIAN FORESTER

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TRIANGULAR *VERSUS* SQUARE PLANTING

BY K. P. SAGREIYA, I.F.S.

Square planting is the commonest practice, and is also the arrangement generally recommended in textbooks on Silviculture. Triangular and quincunx plantings are merely mentioned as possible variations and are only seen in orchards. Why this is so is, however, nowhere clearly stated.

It is sometimes contended that triangular planting is not in favour because—

(1) Physiologically it offers no special advantage over square planting;

(2) The fixing of plant positions is more difficult and expensive; and

(3) Mechanical thinnings to the required intensities cannot be easily carried out.

These prejudices are critically examined in the paragraphs that follow.

There is no definite evidence or indication regarding the pattern to which plant positions approach in nature, in normally stocked crops. Taking the simplest case, *viz.*, a naturally grown crop, standing on a uniform site and containing trees of similar vigour and form, will they tend to arrange themselves in the manner of—

(*i*) *Square* planting, *i.e.*, will they be situated at the points of intersection of two sets of equidistant parallel straight lines at right angles:

(*ii*) Rectangular planting, assuming that wind direction, side-shade, rotation of the earth, or even a regular site-quality or topographical gradient results in larger crown-spread in one direction;

(*iii*) Triangular planting;

or, will they be distributed in a truly random manner? For instance, will teak plants with their decussate branching arrange themselves in the manner of square planting? There is no such evidence forthcoming, obviously because even if decussate branching were likely to promote crown development in the case of free growing trees, in four directions separated by 90° in a crop where the direction of branching will vary from tree to tree, the effects will tend to get obliterated. For the same reason, although the trees may all have a somewhat elongated 'crown' in any particular direction to better withstand the force of the wind, or say, to fully utilise the available sunlight or shade, these factors are not likely to affect the distribution in other directions of the compass. Thus at best the plants will tend to distribute themselves in parallel lines with longer espacement in the direction of wind, etc. Examples of this can often be seen along the edges of plantations and in wind belts.

On the other hand, if the surviving plants, which are assumed to be of equal vigour and similar form, have a natural tendency to make the best use of the available soil reserves and sunlight, they can only do this if they are situated at the vertices of equal equilateral triangles, when they can develop radially in all directions. The nearest approximation to compactly packed equal circles are regular and equal hexagons, because no regular polygons with sides greater than six can fully cover a plane surface. It would thus be quite reasonable to assume that, to best utilise the available growing space the plants will tend to distribute themselves so as to be at the centres of closely packed hexagons, *viz.*, in the manner of triangular planting.

If this is conceded, triangular planting should be preferred to square planting at least from the physiological point of view. There is indirect evidence in support of this deduction. When natural crops are thinned by the "rod method" with a view to evenly space out the stems, the number of stems over a unit of area is nearer the theoretical figure obtained from the triangular planting formula, *viz.*, $N = \frac{\sqrt{3}}{2} \cdot \frac{A}{d^2}$ than the figure obtained from the square planting formula, *viz.*, $N = A/d^2$, where N is the number of stems, A is the area over which they stand, and d is the distance between the adjacent stems. When d is 6 feet, N per acre is 1398 and 1210 for triangular and square planting respectively. In general, the number under triangular orientation is 115.5 per cent. of the corresponding number under square orientation.

The second contention that it is comparatively more difficult and expensive to fix plant positions for triangular planting is not supported by any factual evidence. Here is a simple method which will compare favourably with the usual methods employed for fixing plant positions for square planting.

Staking for triangular planting.—(See Fig 1).—Fix a central stake O on a fairly level ground and round it draw a circle of say one chain radius. On the circumference starting from any point A, mark points B, C, D E and F so that chords AB, BC, etc., are each one

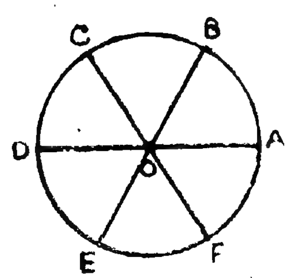


Fig 1

chain in length. Join AD, BE and CF, produce them both ways and fix stakes on these lines starting from O and spaced at the requisite distance d. The space between the lines can be easily filled up by using two rods of length d and holding them so that one end of each is above two adjoining stakes and bringing the other ends together to get the position of the new stake. At any point on a line the directions of the other two lines can easily be determined without the use of a compass, by drawing a circle round the stake and cutting it by chords AB and DC where O is the middle stake and A and B are adjacent stakes on the line DOA. Lines can always be straigthened by aligning.

If the drawing of a cirlce at every step and then determining the directions of the lines is considered too cumbersome, the simple instrument illustrated in *Figure* 2 may be used. It consists of a wooden staff say one inch diameter and five to 5½ feet long, depending on the height of the person using it. The lower end has an iron spike for driving the staff in the ground. On the upper end a

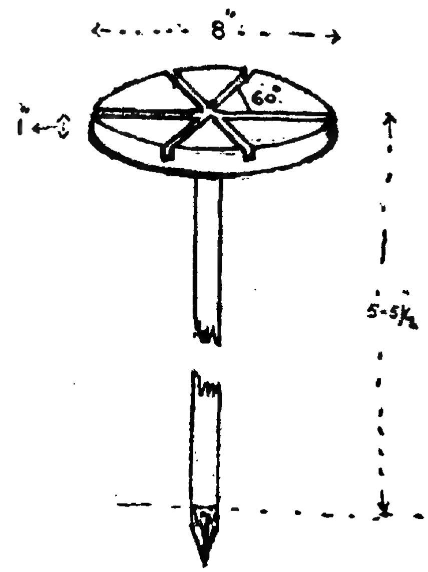


Fig 2

wooden disc eight inches in diameter and one inch thick is fixed centrally and at right angles to the staff with three equally-spaced slits, 1/8 inch wide, cut into it up to a depth of say half inch. It is hardly necessary to say how the instrument is to be used.

Lastly there is the assertion that mechanical thinnings cannot be so easily carried out

with triangular orientation. This assertion seems to be based more on ignorance than on anything else. In fact, as will be seen from the subsequent paragraphs, mechanical thinnings can be carried out as easily as with square arrangement. What is more important, a larger number of variations are possible under triangular planting and thus thinnings to various intensities can be carried out, and it is possible to give more or less uniform growing space to the stems retained. These are illustrated in *Figures 3 to 8*. In all these figures the plant positions are indicated by dots and the growing space available for each plant is indicated by lines between adjacent plants.

Figure 3 (portion marked A, ignoring the cross hatch) shows a rectangular area of a plantation containing 100 plants. It will readily be seen that if d is the distance between adjacent plants the growing space available per plant is $d^2 \times \sqrt{3}/2$, *i.e.*, roughly 31.14 square feet when $d = 6$ feet.

The various intensities of mechanical thinnings that may be carried out are illustrated in *Figures 3 to 7* and an increment felling in *Figure 8*. The terms "very light thinnings," "light thinnings," etc., used by me, are not used in the same sense in which they are used in the standardised grade thinnings of Howard.

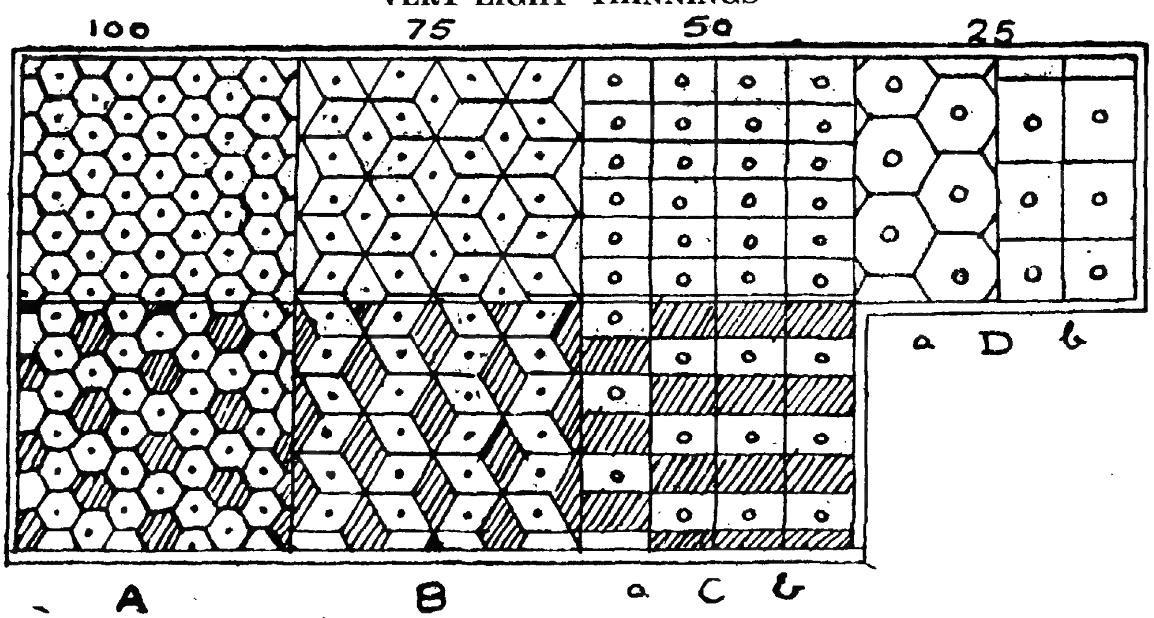
Very Light Thinnings. (Fig. 3).

Thinning ...	I	II	III
Stems retained ...	75%	50%	25%

The upper half of A shows the unthinned crop. The first thinning reducing the stems to 75 per cent. is marked in the lower half. The growing space made available for these stems is shown in the upper half of B. It will be seen that the growing space is not hexagonal but rhomboidal in shape. In other words, the trees have been given freedom to grow only along the longer diagonals of the rhombus. These diagonals are uniformly distributed in three directions separated by

Fig 3

VERY LIGHT THINNINGS



120° which is a better approximation to natural conditions than the arrangement obtained under line-thinnings when all retained plants are forced to grow in the same direction of the compass, *i.e.*, into the space left vacant by the line of plants removed. The lower half of B shows the second thinning marked, reducing the stems to 50 per cent. of the number at planting. The growing space made available to these stems is

shown in the upper half of C. This space is now rectangular in shape and the stems will thus have freedom to develop in two directions in which their growth was so far restricted. The third thinning reducing the stems to 25 per cent. can be marked in two ways. These are shown in the lower half of C at *a* and *b*. The growing space made available is shown in D at *a* and *b* respectively. It is hexagonal under the marking shown at *a* and square under the marking shown at *b*. No more, and in fact not more than two, such light *mechanical* thinnings are ever likely to be needed.

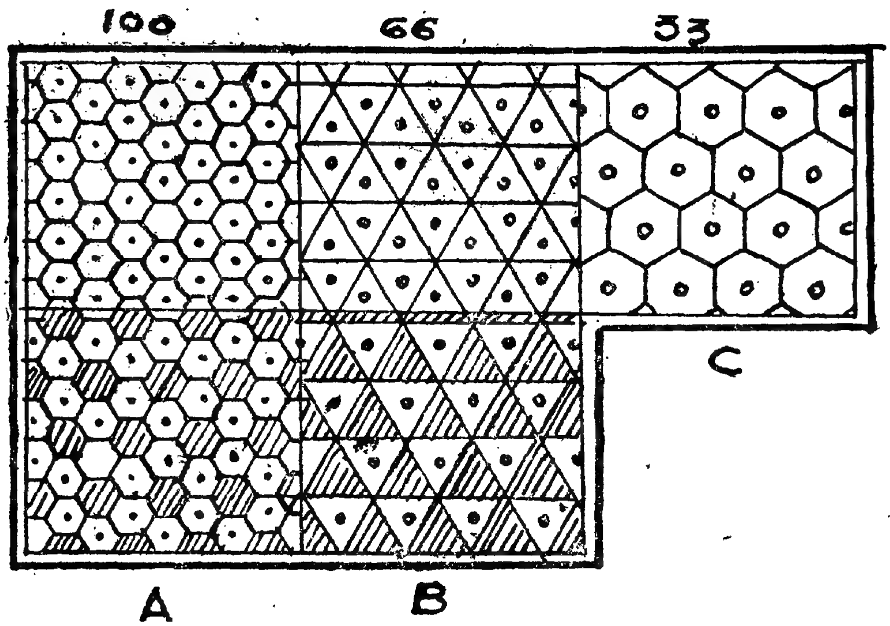
The one point that should be noted is that such very light mechanical thinnings giving uniform freedom to stems retained are not possible with square planting.

Light Thinnings (Fig. 4).—

Thinning	...	I	II
Stems retained	...	$66\frac{2}{3}$%	$33\frac{1}{3}$%

Fig 4

LIGHT THINNINGS



The upper half of A shows the unthinned crop with 100 per cent. stems. The first thinnings reducing the percentage of stems to $66\frac{2}{3}$ is marked in the lower half. The growing space made available for these stems is shown in the upper half of B. It will be seen that this is triangular in shape allowing plants equal freedom in three directions separated by 120°. The second thinning reducing the stems to $33\frac{1}{3}$ per cent. is marked in the lower half of B and the growing space made available is shown in C. This is hexagonal. No more mechanical thinnings are likely to be needed, and in fact by this time the stems would have developed well-defined crowns and the site-quality would have asserted itself, and thus the crops will have to be thinned on the individual merits of the stems.

Moderate Thinnings (Fig. 5)—

Thinning	...	I	II
Stems retained	...	50%	25%

The upper half of A shows the unthinned crop and the lower half the first thinning marked, reducing the stems to 50 per cent. The growing space made available is shown in the upper half of B: it is rectangular in shape. The second thinning reducing the stems to 25 per cent. can be marked in two ways as shown in the lower half of B at *a* and *b*. The corresponding growing space made available is shown at *a* and *b* of C; it is hexagonal or square in shape. No more mechanical thinnings are likely to be possible.

Heavy Thinnings (Fig. 6)—

Thinning	...	I	II
Stems retained	...	$33\frac{1}{3}$%	11 1/9%

Fig 5
MODERATE THINNINGS

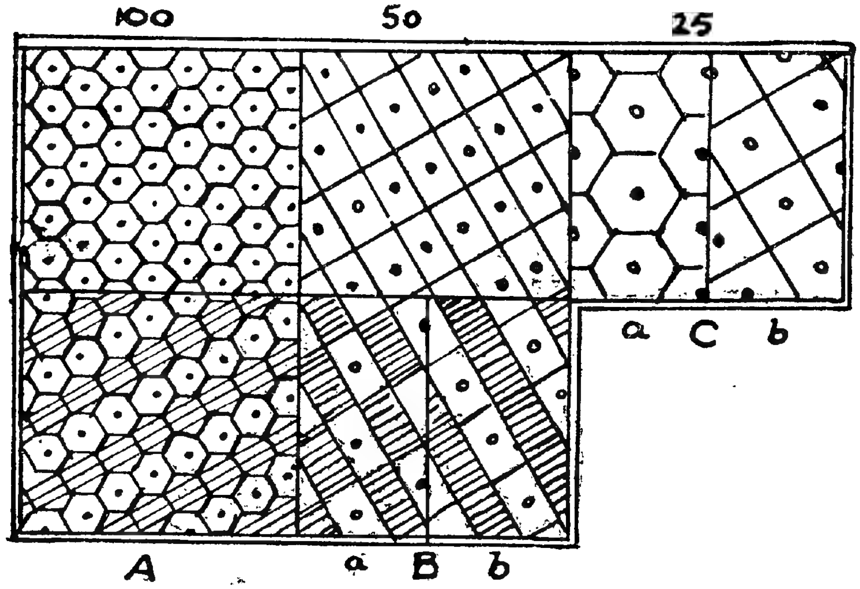
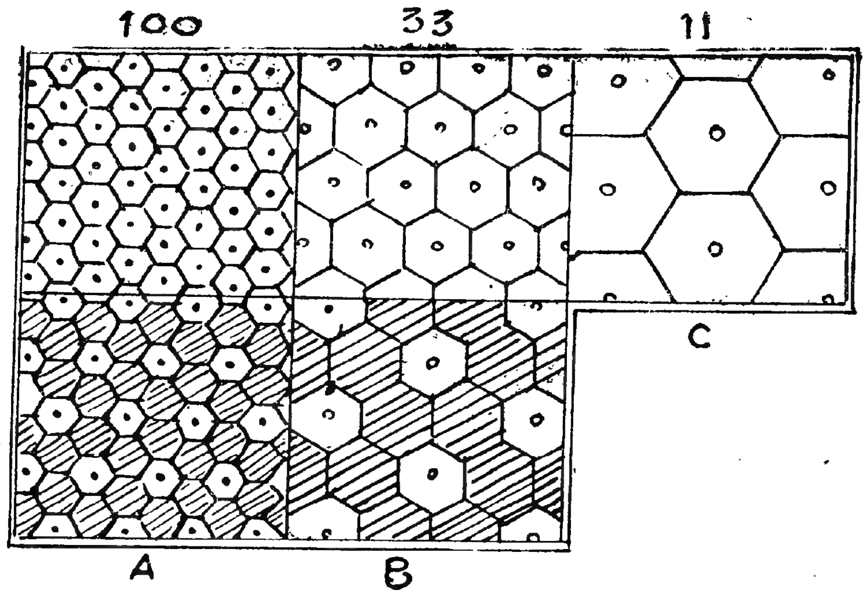


Fig 6
HEAVY THINNINGS



The diagram is self-explanatory. It will be seen that the growing space made available at each thinning is hexagonal in shape. If the second thinning to 11 1/9 per cent. stems is considered too drastic, any of the preceding grades of thinnings could be carried out instead.

Very Heavy Thinnings (Fig. 7)—

Thinning ...	I	II
Stems retained ...	25%	$6\frac{1}{4}$%

The diagram is self-explanatory and the same remarks apply to this as to the heavy thinnings illustrated in *Figure 6*.

Increment Fellings (Fig. 8)—

An increment felling at once reducing the stems to 14 2/7 per cent. is illustrated.

Such heavy fellings are only likely to be used for research purposes or for extremely fast-growing species grown for, say, bark production.

Fig 7

VERY HEAVY THINNINGS

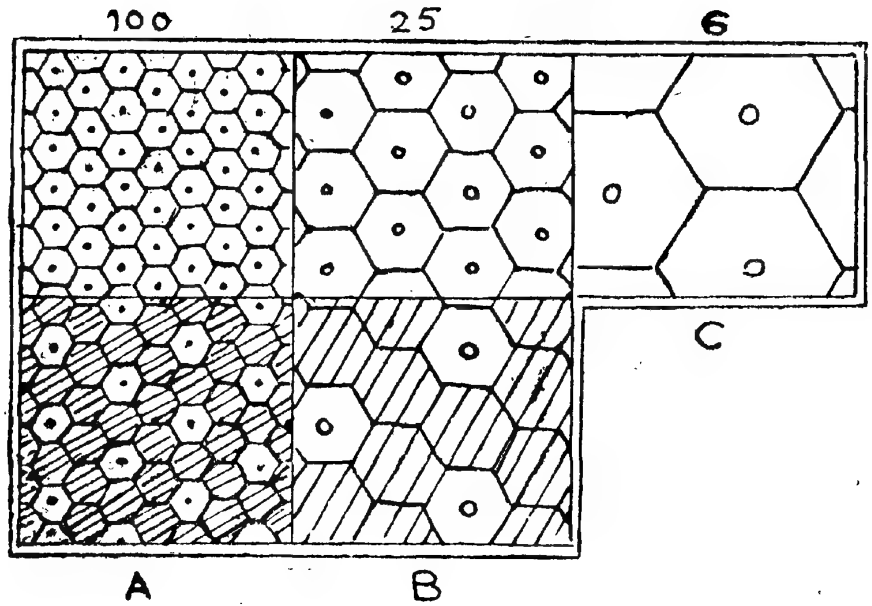
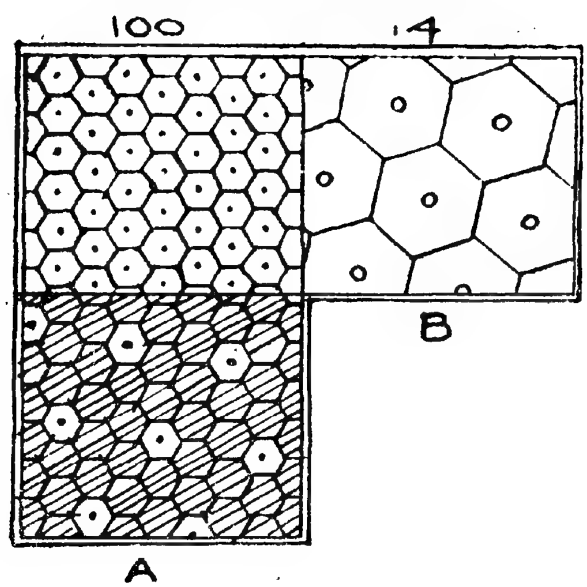


Fig 8

INCREMENT FELLINGS.



It will be readily seen that the various grades of thinnings possible in a triangularly planted crop are:

Before Thinning		After Thinning	
No.	Shape of G. S.	No.	Shape of G. S.
100	Hexagonal	75	Rhomboidal.
100	,,	$66\frac{2}{3}$	Triangular.
100	,,	50	Rectangular.
100	,,	$23\frac{1}{3}$	Hexagonal.
100	,,	25	,,
100	Rhomboidal	$66\frac{2}{3}$	Rectangular.
100	Rectangular	50	Hexagonal.
100	,,	50	Square.
100	Triangular	50	Hexagonal.

and thus actually a very large number of variations are possible.

To summarise, triangular planting is more akin to conditions obtaining in nature and has the additional advantage over square planting that crops can be mechanically thinned to various intensities in such a way that the plants retained have equal freedom to grow at least on two sides.

I would like to reiterate that these thinnings that I have illustrated merely show the *possibility* of carrying out mechanical thinnings, should they be still justified on silvicultural grounds which can be the case on uniform site-qualities and with rapidly growing species. When such is not the case thinnings must be carried out on crown classification basis or other considerations.

"NATURAL REGENERATION WITHOUT SEED-BEARERS"

By

C. W. D. Kermode, I.F.S.

The title of this article has been chosen on account of remarks which the writer found inscribed as a comment on one of the Burma experimental plot files in the Forest Research Institute. A better title would have been "The use of *taungya* in natural regeneration operations." The object of this experiment —badly expressed incidentally—is given as "Can natural regeneration of miscellaneous species in the mixed bamboo forests of Yanaungmyin reserve be obtained and established by cutting and burning and then tending the natural growth subsequently." The commentator remarked that he thought some seed bearers of teak and other miscellaneous species should have been left "otherwise they cannot expect any regeneration." It would appear that the commentator had developed a certain amount of bias which should have been absent from one well versed in the esoteric mysteries of modern experimental methods. The thought of natural regeneration without seed-bearers was evidently too much for him. So it may be for a lot of other people. The object of this article is, therefore, to give a sketch of a regeneration

technique which has been applied in certain types of forests in Burma for the last few years and which, as far as it has gone, shows every promise of producing surprisingly good results. The method is only in its infancy but if it lives up to its early promise it may well revolutionise regeneration operations in some areas.

Artificial regeneration by means of *taungya* is so well known now that it hardly needs explaining but in view of what is to follow a few words are necessary about it. Briefly it consists of the raising of a planted tree crop in conjunction with agricultural, vegetable or even fruit crops. The area to be regenerated, after all marketable timber has been removed, is handed over to the *taungya* cutters who fell everything that is left on the ground, burn all this felled material as soon as it is thoroughly dry, then in the rains grow their own crop and in addition plant tree species at a spacing which is almost universally in Burma now six by six feet. At the end of the first year, when crops are reaped, or later in some of the more specialised *yas* where crop cultivation may go on for several years, the Forest Department takes over a plantation of young trees which has to be kept weeded and cleaned and later on thinned. The method is so well known and used in Burma that in some Lower Burma divisions the year's taungya operations go through like a drill movement. In fact there were for a time in use in some divisions ten forms on each of which was one order. These dealt with date of seed collection, date of felling, date of burning, etc. They were all issued in due season by the Divisional Forest Officer to the range officer who had to return each by a specified date stating that the order had been carried out.

This method of raising a young tree crop paid no attention to any regeneration that was on the ground before the *taungya* was cut. In fact there was no particular reason to take an interest in it. The area was to be planted up with a new crop, usually of one species, which was suited to the soil conditions and which would be, or was expected to be, much more valuable than the natural crop, already disposed of. It was generally assumed that whatever regeneration was on the ground before cutting the *ya* would be largely destroyed by the fire and subsequent cultivation. It was known that vigorous stumps of trees up to several feet in girth often escaped destruction and sent out coppice shoots. Any such natural regeneration that survived or that came up from seed on the ground or accidentally brought in from outside was welcomed as affording a mixed understorey to the main planted crop which would help to preserve the soil and check erosion. So little was expected of it, however, that for years it was the custom to broadcast seeds of accessory species which it was hoped would perform the functions mentioned above. Instructions were that any natural growth or growth from broadcast sowings was to be carefully preserved during weedings. In practice this was at times apt to be difficult or impossible on account of the dense growth of weeds such as *Eupatorium* or *Imperata*. Careful selective weeding through a mass of this stuff would have increased weeding costs greatly so it often became the practice to weed carefully along the planted lines and cut everything between the lines. In spite of this some natural did survive.

Now generally speaking, *taungya* regeneration for the mixed deciduous forests had for years been regarded as the only really feasible way of dealing with large areas in a satisfactory manner. Particularly did this apply to the mixed forest containing bamboo. Natural regeneration methods had been tried with a certain amount of success but had proved to be very costly owing to having to keep the bamboo continuously cut. Regeneration did not come evenly and the result usually was blocks of regeneration of a few acres each scattered throughout the compartment being regenerated.

During the great depression period in the early thirties there was a considerable controversy about the making of plantations and following this Government issued instructions which limited the area which could be made

annually. This area was considerably less than the area being planted each year. At the same time it was laid down that in future more attention should be paid to natural regeneration operations. These instructions were issued somewhere about 1935-36. From then until the fall of Burma natural regeneration operations developed on a considerable scale in forests in which previously natural methods had not been much employed. Two factors were responsible for stimulation of interest in natural regeneration work—that is apart from Government's orders. These were (1) a large scale flowering of the bamboo *Bambusa polymorpha* (*kyathaung*); (2) the increasing demands for forest produce for villagers use from the most accessible forests.

One fact which was learnt from the flowering of the bamboo and which has a bearing on the methods to be described was that on the ground there was a great deal of unnoticed natural regeneration both of teak and other species which only needed the removal of overhead cover to give it a chance. A particular case may be quoted. Two compartments in one division had about ten years before been very heavily worked and practically everything of value removed. Parts of these two compartments were prescribed for regeneration by *taungya* plantations. There seemed to be no natural regeneration. The overwood was light, the undergrowth of bamboo was fairly dense and under that, come in as a result of the opening of the top canopy, a growth of *Eupatorium*. Shortly after the bamboo flowered it was found that a certain amount of teak was showing up above the undergrowth and cleanings and fellings of the overwood were done. As a result it was found that there was a magnificent stock of teak on the ground of which small patches approached plantation density. In areas where previous extraction had not been done suppressed natural regeneration began to go ahead after the flowering and wherever the overwood above good groups was of poor species this was felled.

The need for making arrangements to supply the many villages of the highly populated paddy plains of Lower Burma had become more urgent as the remains of the unclassed forest disappeared and owing to the poor state of the forest it was necessary to open large coupes for extraction annually. Something had to be done about regenerating such areas. The poor state of the forest needs some explanation. The types of forests involved range from dry teak in the north to evergreen in the south. *Indaing* and semi-*indaing* types also occur. Dry teak forest has generally been exploited by trade fellings in the past and very little done about regeneration. At one time plantations were made in this type but numerous failures were responsible for the conclusion that it was not suitable for regeneration by the regular *taungya* method. All that could be done appeared to be improvement fellings to free patches of promising regeneration. The forest generally consisted of a light overwood often with a good deal of teak and a dense undergrowth of bamboo. In its worst state it might be only a little bit better than a dry cane brake. The poor condition can be traced to several causes, *taungya* cutting by local villagers years ago before reservation, regular exploitation and theft—not all necessarily operating over the same areas.

In the poorer quality forests particularly the evergreen and semi-evergreen types regular exploitation had usually been on a small scale and had generally been by trade extraction of big *dipterocarps*. Some of the areas had also been opened to villagers who buy tickets for fuel, houseposts, and sawing logs and do their own extraction. In addition theft had been very heavy in some of these forests. The forest department has never had enough staff adequately to patrol all these forests which from a revenue producing point of view have been of very little value. Consequently they have been rather neglected. With political development and a general agitation for the supply of nearby available forest produce to villagers these accessible forests came into the limelight and a system of working them was in evolution. They had to be properly opened up and they had

to be regenerated. To open them up many coupes had to be opened each year in order that the villager should not have to go far afield to get his needs. Also it was found that often coupes had to be large as the degraded forest contained such a poor stock.

In many cases areas opened were larger than was justified by the estimated felling cycle and size of the felling series but as this was due entirely to the degraded state of the crop it was considered justifiable if a fully stocked crop could be got onto the ground after. 50 acres of well stocked forest would be equivalent to more than 250 acres of the present forest. This may seem an exaggeration but consider what the villagers want; practically only fuel and houseposts. In the degraded evergreen and semi-evergreen forest houseposts of suitable species would probably be not more than one per acre while trees suitable for fuel might be so big that the villager coming in for one or two cartloads of fuel would not be prepared to go to all the trouble of felling and splitting them.

The obvious solution would appear to be to make plantations. In practice this has been done in some of the isolated islands of forests out in the plains known as plains reserves. Many species had been tried and a certain amount of success obtained. Plantations had also been made in the accessible foothills but generally these were of teak and their original object was more for the purpose of growing valuable timber than for supplying village needs. In future no doubt the formation of regular *taungya* plantations will continue on suitable sites.

At the time these plantations were being made nothing like the enormous increase in area of forest to be opened had been visualised. When the opening up really started then the department was faced on the one hand with large areas to be regenerated and on the other by Government's orders restricting plantation making. Also types of forest never before dealt with had to be regenerated and nothing was known about the possibilities of making plantations of such important species as *Xylia* in these areas. Well a lot of trial and error work was done from which the present methods of dealing with these areas have evolved. It is natural regeneration although *taungya* is done but it is developing in some cases into a combination of natural and artificial.

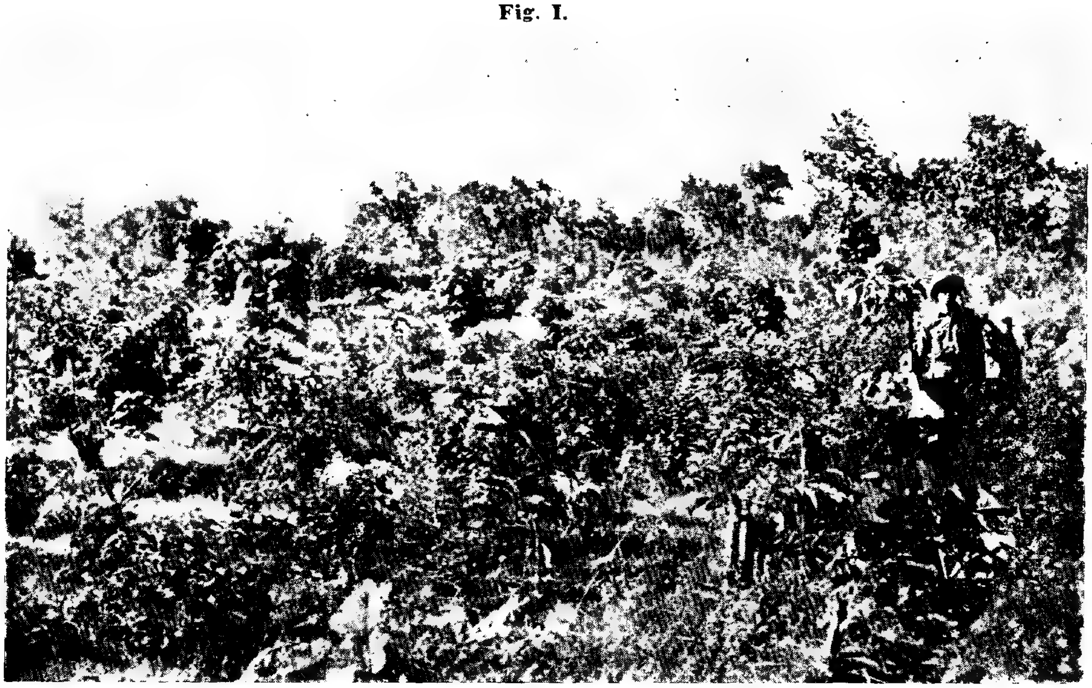
The state of the dry teak forest has already been described. The result of exploitation over many years in the evergreen has been the production of a light forest of a very few big trees, usually scattered *dipterocarps* and smaller trees either too poor to be worth taking or of species of no value. Climbers form a dense mat covering the tops of the trees in places and shrubs and undergrowth may be dense.

As more attention began to be paid to these forests (the worst of them looking like *ponzos*)* it was found that on the ground there was quite a good deal of regeneration of mixed species. Some of it might be up to bigger than sapling size but this larger stuff had usually been so spoilt by its bamboo or climber covering that it was not worth while merely freeing it. The smaller stuff might be seedlings but usually appeared to be plants that had been in existence for some years annually burnt back. Regeneration was always there and later on when assessments were made it was found that it was there even under dense cover in surprisingly large amounts. The problem was how to get it through and not only that how, in areas that contained only species suitable for fuel, to introduce other species which would give good houseposts and timber.

There is no need here to go into the various different experiments in detail but results have got to the stage of demonstrating that ordinary *taungyas* made in several different types of forest will result in a crop which may in some cases exceed 80 per cent. of 6 ft. × 6 ft. plantation stocking. If *taungya* cultivation is not done then all overwood climbers bamboos,

* Secondary growth following shifting cultivation.

Fig. I.



December, 1940. Photo: C. W. D. *Kermode.*

Experimental plot in Dry Teak Forest showing regeneration at end of first growing season, Pyinmana Forest Division.

Fig. II.

December, 1938. Photo: *C. W. D. Kermode.*

Natural regeneration in Eastern Laterite Semi-evergreen Forest. The plot was cut over for a *taungya* and a crop taken off it. Tharrawaddy Forest Division.

etc. can be cut as for a *taungya* and burnt and the same result can be achieved. The former method is preferable on account of cheapness as nothing is paid for cutting also weeding is not necessary in the first year when the cutter is growing his crop. The alternative method of just cutting and burning produces better growth in the first year as, if regeneration is dense, the *ya* cutters must be allowed to lop the early coppice shoots interfering with their crops of all except very valuable species.

As an illustration it is now desirable to return to a consideration of the experiment mentioned at the start of this note. A plot of forest about five acres in which there was no tree growth of value was selected. The original type was poor quality dry teak verging onto semi-*indaing* and there was a lot of bamboo. Everything on the ground was cut and burnt in March 1940. There was the usual hot *taungya* fire. The intention had been to get *taungya* cutters to come and do all the cutting, etc. free in return for which they were to crop the ground but there was no demand for land and the soil was poor. As *taungya* cutters were not available no cultivation took place. The writer inspected the area in June and felt very depressed at its appearance then. There was a fine healthy growth of *Dioscorea* sprawling all over the ground with a few — very few — *Bombax* sprouts. This did not look too good and it appeared as if the fire had killed everything and there had been no seed on the ground to germinate. However growth started in this month and an enumeration late in the month showed that 73.9 per cent. of squares 6 ft. × 6 ft. contained regeneration. At the end of the growing season in December another enumeration was done and it was found that 86.1 per cent. contained regeneration. The percentage of squares containing teak was 8.1 and *Xylia* 4.7. Of these 5.5 teak and .8 per cent. *Xylia* contained plants 3 ft. and over in height. A photograph was taken in the plot in December 1940. Teak can be seen. Open natural forest with dense bamboo lies in background (*Fig.* I, *Plate* 11).

It is necessary to digress for a bit and describe the assessment. Indicator lines were run out across the plot and six feet squares were enumerated on each side of the lines. The indicator lines were marked and subsequent assessments were done over the same lines. 17.4 per cent. of the total area of the plot was counted. Every square which contained a young tree was counted as stocked. If there were more than one in any square it made no difference as the square was stocked when it had one only. Where teak and *xylia* were found they were distinguished from other species, teak being given precedence. For example if a square was found in which there happened to be one teak and two *xylia* it was enumerated as one square stocked with teak. The tallest tree in each square did not necessarily count towards its stocking, the most valuable species did. In tendings of course the less valuable species would be later on eliminated if it was interfering with the valuable one.

By enumerating like this figures for stocking can be immediately compared with those of a plantation formed at the usual 6 ft. × 6 ft. A good teak plantation should be 95 per cent. and over stocked when taken over. The result at the end of the first year was, therefore, in the example given, a stocking which compared very favourably with plantation stocking.

A shock was administered to the writer when Dehra Dun commenting on the first counts made in June stated that the stocking was not 73.9 per cent. as claimed but 6.13 per cent. This did not look so good and a full explanation of the method had to be given. It was argued that in a plantation, when it was enumerated at the end of the first year, each seedling was counted as one and if there were 1210 squares per acre each with one surviving seedling then the plantation was 100 per cent. stocked. Similarly for this method; once the *taungya* had been cut and burnt then the resulting growth had to be looked upon as if it were a plantation. It was completely freed from overhead cover and it would be kept

weeded. No further regeneration was expected from outside and there could be none from seed-bearers. It was therefore quite justifiable to count each square which contained a seedling as stocked. This argument was accepted

As in a plantation it is the stocking at the end of the first season that counts. In plantation work it is now accepted that usually it is not much use filling up blanks in the second year. Similarly here, there would be no attempt to increase stocking by any artificial means in subsequent years. Enumeration of stocked squares was the best method of getting a picture of regeneration as, though it did not necessarily give the total number of young trees on the ground, it gave a picture of the distribution.

Records of counts in 1941 at the end of the second growing season are unfortunately lost but the writer can remember what it looked like. Vigorous regeneration was everywhere. Down on a flat there was a patch of teak that looked like a poorly stocked plantation and trees had reached 10—12 ft. On the hillsides stood out great bushy growths of cutch, *Cassia fistula* and other species 10—12 ft. high with here and there a teak. *Xylia* was also present but not so tall. The plot was in fact a patch of well stocked young dry teak forest with bamboo eliminated. It all seemed so easy and natural. One senior officer who had not actually seen any experiments and was a believer in plantations called the method rather sneeringly the Montessori system. When argued with it was found that he could not believe such a method could be successful because it was too easy. Much more toil and sweat were considered to be necessary before regeneration could be achieved.

One more plot must be mentioned. This was in eastern laterite semi-evergreen forest in Tharrawaddy division. The plot started as an experiment by the Divisional Forest Officer to see if he could make plantations in this unpromising area. The writer saw it at the end of its first growing season (December 1938) and asked if he could take it over as an experimental area. It was not the planted crop that was so interesting, though that was fair enough, but the amazing amount of natural regeneration on the ground (*Fig.* II, *Plate* 11) which had survived in spite of the fact that a field crop had been taken off and that there had been no restrictions on cutters about preserving shoots of natural regeneration. An assessment was made over 20 per cent. of the area and 74 per cent. of stocked squares of natural regeneration was found. At the end of the second year the percentage was 78 and at the end of the third 76. Growth for certain species of the natural is given below as well as growth of the planted species.

HEIGHT GROWTH OF NATURAL SPECIES

Species.	Average height in February 1939	Average height in March 1940	Average height in March 1941
	(Feet)	(Feet)	(Feet)
Pyinma (Lagerstroemia flos reginae). ..	3.2	6.6	8.8
Zaungbale (Lagerstroemia villosa) ..	3.0	8.8	12.7
Aukchinsa (Diospyros sp)	1.6	4.4	9.4
Thande (Sterospermum sp) ..	2.1	6.8	10.9
Petthan (Heterophragma sp) ..	1.7	5.6	8.5
Nagye (Pterospermum semisagittatum)	2.0	5.1	8.1
Myatya (Grewia sp)	3.6	7.9	11.3

HEIGHT GROWTH OF PLANTED SPECIES

Species	February, 1939	March, 1940	March, 1941
	Feet.	Feet.	Feet.
Pyinkado 6ft. × 6ft.	.8	2.7	5.3
„ 12ft. × 3ft.	.6	2.7	5.5
„ 18ft. × 3ft.	.9	3.5	7.6
Zaungbale 6ft. × 6ft.	.9	5.0	7·2

A cleaning and thinning of the surplus shoots of some of the natural was to have been done in January 1942 and the plot was then going to be left until a thinning was due. Two more plots were laid out in this type in 1940 and results were equally good. In one plot left uncultivated but weeded percentage of stocked squares was 72 while in the second cultivated by *taungya* cutters the percentage was 83.4.

More plots were started in 1941. Assessments were to be done in December 1941 and were no doubt carried out but the results were not seen and have now been lost. Inspection of the 1941 plots in the 1941 rains however showed that there was any amount of stuff present. Plots were in dry teak, semi-*indaing* and eastern laterite semi-evergreen. In some *taungya* cutters had cultivated, in others the resulting natural was being tended.

There is a great deal more experimental work to be done. It has got to be determined for one thing how much regeneration must be on the ground before the *taungya* fire to give an adequate crop after. Another important point for investigation concerns regeneration of *Xylia*. Sometimes after a seed year the ground is carpeted with seedlings. It is desirable to discover whether a *taungya* can be cut over these seedlings at the end of their first year and leave enough on the ground alive to form a well stocked crop or whether they have got to be left until they are a bit older before it is safe to cut and burn. Figures from indicator line counts gave in natural forest for dry teak in various areas, 41, 65, and 72 per cent. of stocked squares, and for eastern laterite semi-evergreen 60, 62, 66, 86, per cent. In the semi-evergreen a total of 24.3 acres of indicator lines were counted. In both types there was a fair amount of growth above sapling size. This was not counted. The percentage of stocked squares shown is therefore probably lower than it should be. There is no reason to suppose that these lines contained much less than did the two plots dealt with in detail above. Therefore it is a reasonable assumption that an extraordinarily small amount of what is on the ground gets destroyed. Now the critic can remark "all very well but in many forests there is no regeneration on the ground." The reply to this is—count it out and see. There is far more than is generally realised. Also don't set a standard of requirements of several thousand trees per acre. Less than a thousand per acre is enough.

This method can in a way be looked upon as a form of coppice regeneration in which the *taungya* is the coppicing and cleaning. What comes up in addition to seedlings is from stools that in some cases may be of seedlings of the year before, in other cases of seedlings that have been burnt back to ground level year after year and in others from stools of saplings of fair sized trees. But the great majority of what comes up however is derived

from root stocks that have never produced a tree even of sapling size. Another example of this type of regeneration may be quoted. In pure *Dipterocarpus tuberculatus* forest the ground is often carpeted with "seedlings". These get burnt back year after year and develop into "cabbages". They will not grow up under the shelter of an overwood. When the overwood is removed they immediately start to grow. This regeneration is really in a way coppice because the seedlings have been burnt back year after year but they have probably never developed a stem over 2 ft. in height.

In addition to the experimental work full scale work was carried out at a number of centres in several divisions where *ya* cutters could be induced to come in and cut free. At first this work tended to be a compromise between natural and artificial as, in order to make sure that here should be sufficient regeneration on the ground, seed was sown either broadcast or in lines, stumps were put in and some transplanting was done. In fact in the initial stages far too much was put on the ground. The object of this intensive planting and sowing was to avoid weeding costs. It soon came to be realised that a lot of this supplementing was quite unnecessary furthermore it was an actual waste because generally only second rate species were being used. Later developments have been, in those types of forests in which valuable species were absent, to plant stumps or sow seed of species like teak and *Xylia* at such wide spacings as 15 ft. × 15 ft. or 18 ft. × 18 ft. The ultimate result may be that all plantations of the future which are in very accessible areas will be raised by this method. The valuable species will be introduced at something like final crop or half final crop spacing and will be brought up during life in a matrix of natural forest. Thinning operations will remove trees of other species and these thinned trees will go to serve the needs of the local villages for fuel and in some cases houseposts. The final crop may be houseposts but they will be valuable houseposts which only the rather better off people will be able to afford—the poor man will get his needs from the cheaper type of houseposts from thinnings.

Apart from village supply forests the method will probably be the one used in future to regenerate dry teak forest. Such forest is not usually suited for making regular plantations. There is usually a fair amount of burnt back teak regeneration which by itself is normally enough to give an adequate proportion of teak in the new crop. If it is not considered enough then a few stumps can be put in in places where it is deficient. Assessments of regeneration on the ground before regeneration starts will show whether valuable species are already there or not and the necessity of supplementing or otherwise can be decided before operations begin.

A further development lies in investigations of crops suitable for the poorer quality soils which will be paying enough to encourage *ya* cutters to come in. A two-year scheme of cropping had been worked out with an agricultural expert and a list of crops suitable for growing on poor soil bearing poor dry teak forest or semi-*indaing* had been made. Experiments were to have started in 1942 rains but fate decreed otherwise.

ANDAMAN FORESTS AND THEIR REGENERATION—I

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CHAPTER I—THE ANDAMAN ISLANDS

The Andaman islands, about 204 in number, with an area of 2,508 sq. miles are situated in the South East of Bay of Bengal between latitudes of 92° 11′ and 93° 7′ East. Many of them are small and support not more than 30 or 40 trees, some of them are just awash, or are submerged at high tide and are, in addition to extensive coral reefs, a source of great danger to coastal navigation. The main islands are North Andaman, Middle Andaman, Baratong and Rutland. These are separated by very narrow straits, and may be regarded as forming a single island 156 miles long and about 15 miles broad. Other islands of importance are the Landfall Islands to the North, Interview Island to the West, the Labyrinth Islands to the South West. Porlob, Long Island, North Passage, Colebrooke and Strait Islands on the East, all hug the main islands. The Havelock, Lawrence, Outram and Wilson islands form the Richies Archipelago and lie 5—15 miles east of Middle and South Andaman islands.

COAST LINES

The coast lines of these islands are very irregular with deep and numerous indentations, giving rise to safe harbours for sea-going steamers. In fact, the fleet formed for the attack on Burma in 1824 was able to make its rendezvous at Port Cornwallis. Tidal creeks run many miles inland, literally cutting the islands into the shape of a bipinnately sect leaf. This makes the transport of timber extremely easy.

CONFIGURATION

The Andaman islands are a mass of hills, and the main range of hills runs North and South and rises to a height of 2,402 ft. in Saddle Peak in North Andaman. From these hills, ridges and spurs run in a confused manner, enclosing narrow valleys or a mass of sweeping undulations. Level lands are rare except along creeks or river banks and the sea coast. There are no large rivers, and perennial streams are rare.

CLIMATE

The climate is warm and equable, the mean temperature in the shade varying from 70°F to 90°F, with a perceptible touch of cold during December and January, when fogs and some chilly nights are common. February to April is sultry with very little wind. The average rainfall is about 120 inches, but varies from place to place. Precipitation generally occurs every month, though the bulk of it falls from June to October. Both South West and North East monsoons blow with regularity from May to October, and from November

to January respectively. Cyclones rarely occur, though stormy weather conditions prevail at the beginning of the South West monsoon in May—July and also at the change of monsoons from the middle of October to the end of November.

GEOLOGY

These islands are the summits of a submarine range of mountains, running from Cape Negrais in Burma to Achim Head in Sumatra. The underlying rocks over the greater part of the islands are chiefly non-micaceous hard coarse grained sandstone, indurated clays and slates, conglomerates, pale grey limestones and indurated and altered intrusions of serpentine. Coral formation is found along the coasts. Soft limestone, chiefly of shell sand, soft calcareous sandstones, and white clays with occasional conglomerates are the chief rocks of the Richies Archipelago. The white clayey limestone cliffs in some of the Archipelago islands can be seen from a distance of 25—30 miles.

SOIL FORMATION

The following types of soil formation are easily distinguished and are of considerable importance to the Forester, as the distribution of forest types depends almost entirely on the presence or absence of a particular soil. The main types of soil are:

1. SALINE ALLUVIUM

This is fairly deep and is formed by the clayey or sandy loam deposits brought down by rain water, or by the streams, from the adjoining rising ground. This is found in all bays and creeks, and also along coast line usually sheltered from surf. It forms about 18 per cent. of the total area and is inundated at regular intervals by the rise and fall of the tides.

2. ORDINARY ALLUVIUM

This consists chiefly of a deep fertile clayey loam, or sandy loam, formed in the same way as the saline alluvium. It is out of reach of sea water but very often in the rainy season, because of its impermeable nature, it holds water on the surface for a considerable time. During this period logging work in this area becomes extremely difficult, as the soil becomes a mass of puddled clay, resulting in elephants with their logs sinking knee deep or more. This formation is found along the creeks above the saline alluvium, or along the coast between the sandy beach and the hilly ground, along stream margins and in valleys and depressions. The extent of this formation is about five per cent. of the total area.

3. SANDY BEACH

Consists chiefly of sand and shingle, mostly calcareous, lumps of old coral and broken shells raised by the action of wind and waves just above the reach of high tides. It is extremely porous, and the streams coming down from the hills disappear here to emerge again at sea level or in the sea. This formation is limited to the sea coast and is usually a narrow belt or a small strip.

4. UNDULATING GROUND

This is formed by the disintegration of indurated clays and shales, limestones and conglomerates, the matrix of which is mostly clayey and hard coarse grained non-micaceous sandstones. The soil varies from clayey loam to a coarse rubbly sandy loam and is very shallow in some places. There is no trace of visible humus. It is rich but is dry and water-less in the dry season. It is confined to the lower slopes and the undulating ground between the alluvium and the hills, and it forms by far the largest area about 45 per cent. This formation is rarely found beyond an elevation of 300 ft.

5. HILLS

The hills consist of stiff clayey soil, of dark red loam overlying a micaceous sandstone formation. It is moist throughout the year and there is no scarcity of perennial springs, though the flow of water in the dry weather is small, chiefly due to the catchment areas being small. The high and steep hills, such as Saddle Peak and Mount Ford, consist of hard red brown infertile soil with an underlying rock, very often of an intrusive serpentine.

CHAPTER II—THE ANDAMAN FORESTS

FACTORS INFLUENCING FOREST TYPES IN THE ANDAMANS

The climate, the soil and the past treatment are the main factors influencing forest types in a locality. The Andaman Islands, except for a few wild tribes who have no use for timber, were practically unoccupied until 1858. Since then, about 70 sq. miles have been cleared in the vicinity of Port Blair for the establishment of a settlement. But, until 1870 teak was imported from Burma for all buildings and any timber obtained in the course of clearing, including padauk, was considered useless and was burnt along with other brushwood. The Forest Department was formed in 1883 and it began on a very small scale with one officer, 200 men and 16 elephants, taking out about 2,000 tons of timber per year. It was a long time (about 1925), before the extraction figures reached 30,000 tons. With improved methods of extraction, mainly the elephant hauled short length tramlines, the extraction had reached 60,000 tons in 1941. Also the areas that were considered inaccessible were rendered accessible for economic exploitation. With the increase in accessible areas, the annual possibility of these forests also increased and Sir Herbert Howard, Inspector-General of Forests, after a careful and thorough examination in 1941, found that the yield with a 150 year rotation can be 1,36,000 tons of timber per annum, *vide* his "Note on a tour of inspection in the Forests of the Andaman Islands." This definitely shows that the exploitation of these forests has been only a fraction of what it could normally have been. Moreover these extraction fellings were confined mainly to the coastal areas, and to the areas within half a mile of any tidal creek from which timber could be rafted easily. Beyond this, with only elephants as the motive power to move the logs from stump site, it was considered uneconomical to exploit these forests. Thus, except for about 70 sq. miles cleared for settlement round about Port Blair, and also for the removal of exploitable trees along the coastal fringes and tidal creeks, the whole area is covered with virgin forests, never touched and, in some cases, never explored by any civilized man.

Of the other influences, fire sometimes caused by natural agencies like lightning etc., and invariably caused by human agencies, is the chief factor in influencing forest types in a locality. It holds back the seral progression and has, indeed, enabled *teak* and *sal*, India's most important timber trees, to hold their own, in conditions in which, if fire is excluded, they would disappear, being unable to regenerate themselves in competition with the more shade enduring species that come up as a natural sequence in the progressive succession towards the climatic climax. In fact it is in the seral stage that we find the most economically important forests of the present day, and Foresters are to-day faced with the problem of maintaining these forests in that preclimax stage.

The climatic conditions prevailing in the Andamans are purely tropical, with a mean annual temperature of over 75°F. as shown below:—

January		May		July		November	
Mean	Diurnal range	Mean	Diurnal range	Mean	Diurnal range	Mean	Diurnal range
81.1	10.8	83.8	10.7	81.5	8.0	82.0	9.6

The mean annual rainfall is over 100 inches, distributed throughout the year as shown below:

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1.04	0.72	0.43	3.02	16.64	18.71	15.06	14.40	18.84	11.61	9.44	6.52

(This observation was made in Ross Island, one of the driest parts in the Andamans.)

This rainfall makes a forest fire impossible. Thus, with the elimination of biotic influences, and with the pronounced tropical rainy climate, it is natural to expect climatic climax forests *i.e.*, complete wet evergreen forests. But, a careful perusal of the description of these forests will show, that a large percentage (nearly 50 per cent.) is still in seral stage, with *padauk* (*Pterocarpus dalbergioides*, white *dhup* (*Canarium euphyllum*), *gurjan* (*Dipterocarpus* spp.) and other valuable species—all deciduous or semi-deciduous, still forming the main canopy. Also that the formation of different types of vegetation is purely edaphic and follows closely the classification of soils. As the hills are not very high—the highest is only 2,402 ft.—aspect has very little influence on the modification of forest types in the Andamans. The general character of the growth, except in dry months, appears to be uniform throughout. Deciduous and evergreen forests grow on similar elevations, on similar aspects and in regions of similar rainfall, the sole deciding factor being the soil and the subsoil.

THE FOREST TYPES

According to Champion's classification ("forest types of India, and Burma," page 15) the forests in the Andaman Islands may be divided into:

A—Edaphic preclimax forests, or forests influenced by site factors in addition to climatic factors.

1. Tidal Forests (Mangrove forests).
2. Beach Forests (Beach forests).
3. Riverain Forests (Low level evergreen forests).

B—Tropical or climatic forests.

4. Moist deciduous forests (Deciduous and semi-deciduous forests).
5. Wet evergreen forests (Hill or high level evergreen forests).

N.B.—The classification within brackets is the classification that was in common use in the Andamans.

GENERAL DESCRIPTION OF THE FORESTS

Except for about 70 sq. miles cleared for the settlement, the whole area from the water's edge to the summit of the highest hills is covered with a luxuriant growth of dense forest, characteristic of a region of warm climate, heavy rainfall, and high atmospheric humidity. As a rule, from the ground level up to about 150 ft. or more, it is one mass of green vegetation, tangled together by enormous climbers, thorny canes, and the impenetrable climbing bamboo which carpets the lowest ground and festoons the highest trees. Scrub jungle on high hills and on very steep slopes is the only exception to this rule. Sir Alexander Roger, in his tour of inspection as Inspector-General of Forests in 1927, says that he has never seen a denser forest in any part of India or Burma.

DESCRIPTION OF THE FOREST TYPES

Tidal forests (Mangrove forests).—These forests, locally called Mangrove forests, occupy the saline alluvium and line either side of nearly all the creeks, and portions of the coast line sheltered from the force of the wind and waves. Fringing the coast line, and occupying the lowest elevation, these forests extend as far as the high tide can reach. Growth is very level and, in some cases, they are clipped like a flat topped hedge by parakeets. These forests, with their heavy and

dark green foliage, are a very pleasing relief to the dreary expanse of the sea, and form a beautiful setting for other types of vegetation occupying higher elevations.

Of the species represented the most gregarious and predominating are *Rhizophora mucronata* and *Rhizophora conjugata*. These are found almost exclusively on the outer limits facing the sea. Closely set and forming a strong and effective sea wall with masses of stilt-like roots, they are extremely difficult to penetrate. Immediately behind this, on slightly more raised ground, and where the influence of fresh water is felt, are found two other species, *Bruguiera gymnorhiza* and *Bruguiera parviflora*. The former is the largest species of mangrove and is next in abundance and gregariousness only to the *Rhizophoras*. Where it does occur, it gives the appearance of a well tended plantation, with clear boles 60—80 ft. high, a girth of 5—6 ft. and with a clean floor except for the numerous knee roots. These four species form very good fuel and are considered next best to coal by the crews of the steam launches. *Avicennia officinalis*, with numerous pneumatophores, also forms occasional gregarious groups. Other species of true mangrove habit are about 15 in number but are not so common. *Ceriops candolleana, Kandelia rheedii, Carapa obovata, Carapa molucensis, Sonneratia acida, S. alba* and others are found dotted about everywhere. *Heritiera littoralis Phœnix paludosa, Nipa fruticens, Licuala spinosa Barringtonia racemosa, B. speciosa* and *Brownlowia lanceolata* form the outward fringe of the swamps that are reached only by the spring tide, and gradually give rise to other types of vegetation. It is estimated that about 160 tons of timber per acre are available (Inspector-General of Forests note on a tour of inspection 1928) and the area occupied is roughly 450 sq. miles, or 18 per cent. of the total area.

Beach Forests.—Just above the high tide and exposed to the full force of the monsoon winds, these forests are found lined along the coast in narrow belts from a few yards to a furlong or more in width. They grow on sandy beach formed by sand and shingle banked up by wind and waves, and also on the detritus brought down by streams. These forests act as very efficient shore protectors and wind belts, especially on the West coast where the contorted appearances of *Mimusops littoralis*, the predominating species of this formation, tells its own tale. On the loose knit sand, often reached by high tide, *Ipomaea biloba, Crinum asiaticum, Vigna retusa, Pandanus tectorius, Scaevola koenigii*, and a few others form the only growth. Behind these, and on firmer soil, only sometimes reached by high tide, we have *Hibiscus tiliaceus, Morinda citrifolia, Thespesia populnea, Pongamia glabra, Desmodium umbellatum, Gyrocarpus americanus, Erythrina indica, Barringtonia speciosa, Calophyllum inophyllum Terminalia catappa, Cordia subcordata.* Most of these lean out towards the sea, and sometimes, heavily laden with straggling shrubs and climbers such as *Colubrina asiatica, Caesalpinia bonducella, Mucuna gigantea* and various *Ipomeas. Mimusops littoralis*, the towering giant of the littoral forest, sometimes grows pure on flat and deep sand deposits. The total area of this type of forest is negligible and is about one or two per cent. of the total area.

Riverain forests.—Southern tropical semi-evergreen (Low level evergreen forests).—Leaving the tidal and beach formations, unless the ground rises abruptly, we come to what may be termed the low level evergreen forests; the densest in the Andamans. This type is confined mostly to the ordinary alluvium, which forms the banks of larger streams, moist valleys and depressions, and the inner extensions of tidal flats. This alluvium is immature but is sufficiently old, and sufficiently raised above flood level to give rise to a magnificent growth of the species found both in deciduous and in evergreen area, very often with huge buttresses. Climbers and cane brakes are very heavy and make penetration extremely difficult.

Dipterocarpus alatus, the biggest and the grandest tree of the Andamans, with its usual associates *Dipterocarpus pilosus, Sterculia*

alata, S. campanulata, Terminalia bialata, T. procera, Albizzia stipulata, A. lebbek, Calophyllum spectabile, Bombax insigne, Artocarpus lakoocha, A. chaplasha and *Pterocarpus dalbergioides* form the predominating species and occupy the topmost storey of 100 ft. and over. Below this, forming the 2nd storey between 50—100 ft. are found *Lagerstroemia hypoleuca, Dillenia pentagyna, Dracontamelum mangiferum, Pometia pinnata, Myristica irya, Pisonia excelsa Litsaea panamonja, Xanthophyllum andamanicum*, and many others of less importance. Forming the lowest storey are found *Fagraea morindifolia, Talauma andamanica, Garcinia andamanica, Macaranga tanarius* and *Aporosa villosula*. The ground is usually covered with *Saprosma ternatum, Maesa andamanica, Micromelum pubescens, Clerodendron infortunatum, Leea sambucina* and *L. acuminata, Clinogyne grandis, Licuala peltata, Caryota mitis Areca triandra, Oxytenanthera nigrociliata*, and also *Saccharum* in open places.

Of the climbers and straggling shrubs and canes, *Dinochloa andamanica* (a climbing bamboo), *Thunbergia laurifolia Ipomaea* spp., *Buettneria andamanensis, Combretum extensum C. chinense, Deamonorops kurzianus, D. manii* and *Calamus palustris* form a rampant growth trailing over the ground and climbing into the highest trees. Only the top storey trees, and a few in the 2nd storey, are really deciduous and that, only for a short time.

Tropical moist deciduous forests.—Rising from the tidal, the beach or the Riverain (the low level evergreen forests) and covering all the undulations, and extending 300 ft. or more up the hills and ridges as far as the soil conditions permit, these forests (locally called *padauk* forests), form the most important reserves of timber wealth of these islands. They cover as much as 45 to 46 per cent of the total area.

Padauk the most important and predominating timber species of these islands, with its equally important associates *Terminalia bialata, T. manii* and *T. procera. Canarium euphyllum, Sterculia campanulata, Bombax insigne, Lagerstroemia hypoleuca, Tetrameles nudiflora, Chukrasia tabularis*, and in moist localities *Artocarpus chaplasha, Dipterocarpus alatus. Parishia insignis, Bassia butyracea* and *Albizzia lebbek*, form the topmost storey over 100 ft. in height. These trees, with their huge buttresses (especially in the case of *Tetrameles nudiflora, Padauk* and *Terminalia bialata*) are scattered and their widespread crowns rarely meet. Below these giants, and forming the second storey of over 50 ft. and making a fairly complete canopy, are *Lannea grandis, Adenanthera pavonina, Sterculia villosa, Dillenia pentagyna, Aglaia andamanica, Diospyros marmorata, D. pilosula, D. pyrrhocarpa, Miliusa tectona, Sageraea elliptica, Cratoxylon formosum, Semecarpus kurzii, Zanthoxylon budrunga, Celtis wightii, Cinnamormum zeylanicum, Cobtusifolium* and *Pterospermum aceroides*. Below these, forming the third storey are found *Murraya exotica, Atlantia monophylla, Limonia alata, Canthium glabrum, Ixora grandiflora, Grewia laevigata*, and the small bamboos, *Oxytenanthera nigrociliata* and *Bambusa schizostachyoides*.

Of the shrubs covering the ground, the most common are *Alsodeia bengalensis, Mallotus acuminatus, Actephila excelsa, Randia longiflora, Harrisonia brownii, H. bennettii, Glycosmis pentaphylla* and *Licuala peltata*.

The most common climbers and straggling shrubs, which connect these different tiers in the canopy, are *Ventilago madraspatana, Delima sarmentosa, Buettneria andamanensis, Acacia pennata, Entada scandens, Plecospermum andamanicum Sphenodesme unguiculata* and a variety of canes.

Tropical wet evergreen forests (High level evergreen forests).—This is confined to the hills and ridges and to the serpentine outcrops, which emerge abruptly from the deciduous forests, which may be termed high level evergreen forests. It is on these outcrops, and on the lower slopes of the higher hills that we have the true and the most luxuriant growth of evergreen forest. the grandest of all the Andaman forest types.

Every tree is clear boled and reaches great heights, requiring field glasses clearly to see their leaves. The principal species, *Dipterocarpus grandiflorus* and *D. pilosus* together with their associates. *Artocarpus chaplasha* and *A. gomeziana, Calophyllum spectabile, Planchonia andamanica, Hopea odorata, Endospermum malaccense, Sideroxylon longipetiolatum,* and occasional *padauk* and white *dhup* (*Canarium euphyllum*) form the upper storey. Below these, forming the second storey between 50—100 ft., are found *Xanthochymus andamanicum, Pometia pinnata Messua ferrea, Baccauria sopida, Podocarpus nerifolia, croton argyratus, Pterospermum aceroides* and *Myristica* spp. Small trees are few and they are mainly *Mitrephora prainii, Actephila excelsa* and *Caryota mitis.* The chief climbers are *Dinochloa andamanica, Gnetum scandens, Ancistroctadus extensus* and a variety of canes. These connect the crown above, and lie in snake like coils on the ground below.

On high hills, such as Saddle Peak in the North Andaman, Mt. Ford in Rutland Island, and also on some of the ridges in other islands, with hard red brown infertile soil, the magnificent height growth of trees, found in other formations, disappears. The trees become small and stunted, rarely more than 30 ft. in height and 2—3 ft. in girth. They are more numerous and grow close to one another. The main species in this formation is *Dipterocarpus costatus,* with occasional *Messua ferrea, Cratoxylon formosum, Canarium manii,* and *Hopea andamanica.* The main shrubs are *Memecylon caeruleum* and some varieties of small bamboos, and also a variety of *Phoenix.*

PRESENT CONDITION OF THE FORESTS

Though the Andaman forests are very dense, the proportion of really valuable species is very small and these are found scattered in a useless crop all over the area. Recent clear fellings in regeneration areas showed that very rarely is the yield per acre of merchantable timber more than 16 tons. Sir Herbert Howard, in his note on a tour of inspection in the forests of the Andaman islands, page 6, says "The average yield from a clear felled area at present is about 15 tons per acre though many areas give a good deal more . . . . I saw in the Happy Valley a place where 70 tons per acre was actually standing and it was not by any means fully stocked." It is therefore clear that these forests, as far as valuable trees are concerned, are very poorly stocked indeed.

The present condition of the crop is that the valuable species. with few exceptions, are mostly deciduous or semi-deciduous, and occupy the topmost storey. These are overmature with a large percentage of hollow and unsound trees. Younger age classes are very poorly represented or even non-existent.

This is especially so, in the case of *padauk* which remains sound until it reaches a girth limit of 9 or 10 ft. After this, it usually becomes unsound, but continues to grow to enormous size. Trees of 25 to 30 ft. girth, completely hollow and with only a thin shell, are a common feature in these forests.

Below these trees, everything is evergreen and is of little use at present. It forms a thick and impenetrable mass.

The only exception to this general rule are the wet evergreen forests, in which the vegetation from the ground level is completely evergreen. The main crop, mostly *Diptero carpus* (other than *alatus*) are mature or overmature. Younger age classes from the seedling stage are not wanting, though they are not found by any means to the extent desirable in a normal forest.

In all these types of forest (except tidal forests) the trees grow in the form of mixtures of single trees. *Dipterocarpus kerii* is, however, an exception, and grows pure with all age gradations represented from the seedling to the mature tree. But the area occupied by *kerii* is very small and is limited to Gobang in South Andaman. It is one of the most remarkable types of forest, forming the most excellent example of perfect uneven aged forest.

PROBABLE CAUSES FOR THE PRESENT ABNORMAL STATE OF THE FORESTS

Champion thought that the Andaman soil is still immature, and that the forests have not had enough time to reach climatic climax. The species now most valuable, *viz., padauk* and its associates are only transitory, and are gradually being replaced by climax formation. His observations were based on the recent description of the forests. Kurz in 1886, and Oldham in 1894, thought that these islands were the residue above water of a submarine subsidence which was still continuing, and this theory was further supported by Sir Richard Temple in 1901. Some other observers, however, are of the opinion that both subsidence and upheaval are still going on.

Recent upheavals and subsidences account for the fact that there are still areas, especially the riverain tracts, with an almost pure crop of *Anthocephalus cadamba,* a species which is one of the first to make its appearance in a new soil, and is also one of the first to make its disappearance with the progressive development towards climatic climax. The size of these trees, rarely more than 5 or 6 ft. in girth, clearly shows that at least these tracts are not very old.

Mr. B. B. Osmoston in 1908 (Indian Forest Records Vol. I Part III page 241) referring to *Padauk,* says "saplings and young poles, as well as trees below 6 ft. in girth are very scarce indeed. This remarkable disparity in the age classes can only be explained by assuming that there has been a recent change in the condition of the vegetation in the Andamans: the conditions under which the existing crop of mature and overmature trees arose, having given place to others unsuitable to the successful reproduction of *Padauk.*" Professor Troup, in his book, The Silviculture of Indian trees, says "Frequently the change takes place by reason of conditions (moisture, shade, etc.) produced by the formation itself." What is true of *Padauk* is also true of other deciduous and also of evergreen species, *viz., Gurjan* (*Dipterocarpus*) *lambapathi* (*Sideroxylon longipetiolatum*) and *Bakota* (*Andospermum malaccense*). Whatever may be the cause for this change, we have now got to face the fact that the Andaman species, now well known in the market, are only transient and a stage in the progressive succession towards climatic climax and may fade away unless Foresters step in and prevent this disaster.

(To be Continued)

ACACIA CATECHU VAR. SUNDRA

Commercial names: *RED CUTCH, LAL KHAIR*

BY

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Introduction.—About a year ago a piece of timber was sent to the Forest Research Institute, Dehra Dun, by the Director-General of Shipbuilding and Repairs, Bombay, for identification. We were told that this timber had proved to be a good substitute for Lignum-vitae (*Guaiacum officinale*)—a South-American timber—usually used for propellor tail-shaft bearings. During the present war, there has been some difficulty in obtaining Lignum-vitæ and the Director-General of Shipbuilding and Repairs, Bombay, used this Indian timber and found it to be a good substitute for Lignum-vitæ. He wanted to know the identity of this timber which was supplied to him by some contractors under the name of "Red ebony." No further information was given out by these contractors, as to the locality from which it came or the quantity that was available in the country. He was told that it was an Indian timber and nothing more.

The importance of the identification of this timber is apparent. For, when the name of the timber is known, we are in a position to locate the sources of its supply. At present this timber is in a great demand in India for the purpose of bearings.

Results of investigation in the laboratory.—The timber, on examination, appeared to belong to the family *Leguminosæ*, but not a single specimen of wood in the Forest Research Institute collection, which includes both Indian and foreign timbers, could be matched with it. At first it was thought to be a foreign timber for which there was perhaps no sample in our collection. But later on careful microscopic examination showed that it had anatomical structure to some extent similar to that of the *Acacias* and particularly of *Acacia catechu*. Then an attempt was made to find out the reason for its difference in anatomical structure from the *Acacias* in our wood collection. The only reason that could be thought of, for its finer texture and more abundant gum-like deposits in its various types of cells, was probably its xyrophytic conditions of growth. In the meantime, wood specimens of various *Acacias* growing in the Bombay Presidency were obtained. When these were studied under the microscope, one particular specimen showed a great similarity to the timber sent by the Director-General of Shipbuilding and Repairs, Bombay. On reference to the annual rainfall of this particular locality, it was found to be below 20 inches. Thus the hypothesis drawn at the early part of the investigation was confirmed.

Field investigations.—At this stage the contractors who supplied this "Red ebony" were again asked to divulge the identity and sources of supply of the timber. But they very naturally refused, saying that it was a trade secret. Then a visit to Bombay City was made and the godowns of many large and petty timber merchants were thoroughly searched. It was thought that this, being a Bombay timber, might be available in the stock of some timber merchant who did not know the special use of it. Although no stockist had any sample of the so-called "Red ebony," yet it was found possible to get a clue to its identity. Actually, a year ago a sawmill used this very timber as pillars for the construction of its mill. The source of supply was from Baria State in Gujrat. A visit was then made to the Baria State and some more specimens of this timber were collected. I also visited forest in the Baria State and collected some botanical specimens of "Red ebony" which were subsequently identified by the Forest Botanist as *Acacia catechu*, Var. *sundra*.

Commercial name of the timber and its source of supply.—It is not advisable to call this timber "Red ebony" as it has no family connection with the ebonies. I would suggest two commercial names, "Lal khair" or "Red cutch." These names will indicate its affinity to *khair* and cutch and are not likely to cause confusion in the market.

The tree is known to grow in Coimbatore, and in the Deccan, north of river Krishna; common also in Kanara and Konkon, Kathiawar, Rajkot, Gujrat and Rajputana.

Tentative specification for obtaining this timber.—It has not been possible for me to examine many wood samples of *Acacia catechu* Var. *sundra*, and the specification given below is only tentative. Moreover, no sample of this timber should be put on trial without my examination, for it is most unlikely that all wood samples of *Acacia catechu* Var. *sundra* will prove good substitutes for Lignum-vitæ.

(*i*) Trees should be of fairly large size. Trees or logs less than two ft. in diameter are not likely to give timber of required quality.

(*ii*) When examined with a hand lens, all types of cells should be full of gum or gum-like substances.

(*iii*) While cutting a block of wood, the action of a knife across the grain should show the timber to be very hard but uniform in texture. This is very important from a practical point of view.

(*iv*) The colour of the timber should be red instead of reddish to blackish-brown.

The Utilization Officer, Forest Research Institute, Dehra Dun, will be glad to hear of further sources of supply of *Acacia catechu* Var. *sundra*. The more samples are examined the better, but samples shoud be accompanied by botanical specimens, and the wood of young trees should not be sent.

My acknowledgments are due to Mr. Kesarcodi, Forest Utilization Officer, Poona, Bombay; Mr. Kuppuswami, Director, Timber Directorate, Bombay; Mr. Parikh, Divisional Forest Officer, Panch Mahal, Bombay; Mr. Pithwa, Forest Officer, Devgad-Baria, Baria State; Mr. Purshottam Das, Sunder Das Saw-mills, Bombay; Mr. Raizada, Asstt. Forest Botanist, Forest Research Institute, and Dr. Krishna, Bio-Chemist, Forest Research Institute, for the help they have given me during this investigation.

EXTRACTS

THE COMING OF PLYWOOD

A REVOLUTION IN THE UTILIZATION OF TIMBER

The return to wood in the construction of certain types of aeroplane has given rise to some new factors in the future utilization, or perhaps more correctly expressed, in modifications in the utilization of the remaining timber supplies of the world. Generally speaking, the most important property in materials used in the construction of aeroplane structures is great strength combined with lightness. As a result of research in India (vide *Ind. For. Records*, "Indian Timbers for Aircraft and Gliders." Delhi: Manager of Pub., 1942) the strength to weight ratios for several materials are as follows: material, Sitka spruce, M. of R./sp. gr., 25,500; Douglas fir 24,000; Indian spruce, 26,000; Indian fir, 25,900; ash, 25,800; teak, 24,800; *Michelia excelsa*, 25,100; *Polyalthia fragrans*, 21,300; *Phoebe goalparensis*, 22,600; *Canarium euphyllum*, 22,400; duralumin, 21,300; carbon steel, ordinary, 12,700; nickel-chrome steel tempered, 23,600.

These figures at once give the reason for the pre-eminence of spruce in aircraft construction in Europe and America. Weight for weight, it is stronger than the best alloy steel and much superior to duralumin, of which a great many metal aircraft are constructed. Owing to its low specific gravity, timber is also suitable for long members subject to buckling or combined binding and compression. In such cases it is said to be generally easier to increase considerably the moment of inertia of a timber section by simple processes than is possible with metal members without increasing the weight. It may be briefly mentioned that timber is used in aircraft construction in the wings, body-work, tail, airscrews, and the covering of the framework. For the main members, such as the spars which support the wings, the longerons which support the body framework, and the tail members, only faultless timber of the highest quality is accepted. For these parts and other members of the framework, selected Sitka spruce is usually used. Wooden airscrews are mostly of walnut and mahogany. In the covering of the wing surfaces and body frames plywood is used, selected birch being one of the best woods. The construction of gliders is similar to that of aeroplanes, and requires the same consideration of strength and weight. It thus becomes evident that very strict specifications must evidently be in force, and only timber

of the highest quality will be accepted for aircraft construction. But a high proportion of this material is required in short lengths only.

In connexion with plywood generally, a "Note on the Manufacture of Plywood in India" (*Indian For. Rec.*, Utilis., Res. Inst. Delhi: Manager of Pub., 1942) gives information on the prospects of the industry, on existing plywood mills in the country, on possible areas for exploitation, in glues and the manufacture of plywood and tea boxes. It also discusses the machinery required for a plywood mill and the manufacturing costs. A list of timbers considered suitable for plywood work in India is also given. Plywood research is not new to the Research Institute at Dehra Dun. For many years since its inauguration this research was carried out by Mr. W. Nagle, the officer in charge of the Wood-working Section. He retired in 1940, the memorandum in question being written by S. W. Kapur, who has had the additional advantage of having studied Japanese methods of plywood manufacture.

The question of veneers, the foundation of plywood, is dealt with in another publication (*Ind. For. Leaflet* No. 34. Dehra Dun, U.P.: For. Res. Inst., 1943) entitled "Types of Seasoning Kilns suitable for Drying Indian Woods," already referred to in *Nature*. On these questions of seasoning veneers the following is of importance: "Thorough seasoning of veneers before gluing and manufacture into plywood is very important, if satisfactory plywood is to be made. Green veneers can be air-seasoned or kiln-dried exactly like ordinary wood. The usual method in Europe and America, for the quick seasoning of veneers is to dry them in long progressive dryers. These dryers are closed metal chambers 50 ft. to 100 ft. long, fitted with powerful fans for the rapid circulation of air, and with steam-heated pipes for raising the temperature of the air circulating inside the dryer. The green veneers are fed into one end of the drying chamber and slowly moved towards the other end by means of endless belts or between rollers fixed along the length of the dryer. The speed at which the veneers move can be controlled, but they are usually dried in the course of a few minutes which they take to travel from one end of the dryer to the other. Unfortunately progressive dryers are very costly."

It is pointed out, however, that the above type of dryer is not essential for the quick seasoning of veneers, and it is possible to use certain other types of cheaper kilns.

Under the title "The Forest Giant goes to War" (*Christian Science Monitor*, January 9, 1943) details are given of the heavy fellings being made in forests in the United States. The following extract portrays an increasingly serious position. "Even within the Douglas fir region itself, where the facts are at hand, there are forebodings that the tide of war demands for 'the most critical species of lumber in the United States' will leave a wake of wholesale destruction in this incomparable resource. The production of what the trade terms 'West Coast lumber' from the region of 1941 was 8,500,000,000 feet. This was principally Douglas fir, but also included its companion species—West Coast hemlock, Sitka spruce, and Western red cedar. In 1942, production was running about 3 per cent. ahead of 1941, despite severe shortages in manpower and equipment. The annual war-time cut is thus roughly $1\frac{1}{3}$ per cent. of the region's stand of all species of sawtimber. One fact of importance on this figure is that the choicest grades of timber, such as airplane spruce and 'peeler' Douglas fir, are being overcut. Certain areas also are being overcut, particularly the forests that remain close to tidewater and to rail outlets."

Plywood has now become one of the chief factors in timber utilization. This new factor may be well termed revolutionary in its future possibilities, coupled with the modern plywood mill or factory. In professional circles the latter was regarded as more or less of a Cinderella before the outbreak of war, and only the few visualized it as one of the chief methods of utilizing timber in the future. War developments would seem to have proved this without any reasonable doubts. How will this benefit mankind? It is not difficult to frame an estimate. The exploitation of the primeval forests of the globe, both conifers and broad-leaved, have in the past left much

to be desired, the waste in conversion, both in the forest and the sawmill, having been excessive. The forest war fellings are accentuating this deplorable wastage. In the past, in the tropical forests consisting of a large number of species growing in mixture of which so far but a few have had any marketable value, and only one or two of these a world value, the waste in extraction of these latter, owing to the excessively high specifications laid down by the buyer, has been enormous. Great logs with slight external flaws in them and giant butts which would not fulfil the buyer's terms were left to rot in the forest—material of a priceless value. Outside the forest has lain in wait the sawmill. These latter have been vastly improved during the past half-century—but it has not proved possible to eliminate a considerable waste in conversion, especially in saw-dust. It is being demonstrated that the modern plywood mill has reduced the waste of timber, the raw product, to a very low percentage. So far as the remaining hardwood forests of the world are concerned, tropical and otherwise, plywood utilization would seem to indicate that their economic life (that is, utilization) can be prolonged, if not indefinitely, at least for a far longer period. For one thing, by means of plywood a larger number of previously unutilizable species in the great rain and deciduous tropical forests will become commercially practicable; while the appalling waste in the conversion of the so-called luxury timbers, current up to date, can in future be eliminated to a considerable extent by the erection of a modern plywood mill in the vicinity of the forest under exploitation.

The modern plywood mill, more correctly designated perhaps as a factory in its most up-to-date war-built design, may be regarded as considerably ahead of its predecessors, and has been the outcome of much thought and careful planning on the part of men who had made a thorough study of the problems to be met. Its erection involves a considerable initial outlay, which during war-time, it is said, has been fully justified due to two facts: the finished product is of the highest order and it is produced very expeditiously.

It is not the object of this article to describe the mill and the various stages through which the material produced by the rotary cutter or peeler machine finally emerges in its plywood form. It is the possible enormous increase in out-turn per unit of forest to which attention is here directed. The logs— the larger the diameter the better within limits— arriving at the mill are cross-cut to the size required, not less than 7 ft., for the rotatory cutter, which is really a large-scale lathe. The barked log is placed between two spindles which are clamped into the centre of the ends and rotated against a fixed knife which runs the whole length of the log and thus takes a thin shaving off the whole circumference. The knife moves forward at a set speed, which is dependent upon the thickness of the shaving. It will be understood that until the log has been turned to a perfect cylinder only scrap material comes off, though even this is utilized. Once a perfect cylinder is achieved, the veneer comes off as a continuous (moist) sheet which is wound on to a drum. Veneers as thin as 1/90 in. can be cut in the most modern machines. The logs are turned down to an 8—9 in. diameter core. The core may have defects, but in any event below this the small radius of curvature renders it brittle, the veneer thus splitting. The cores are now made use of for other purposes. In fact, in the modern mill, waste has been almost entirely got rid of. The roll of veneer after leaving the rotatory cutter passes through a number of processes before actually arriving at those in which its manufacture into the particular type of plywood being turned out is undertaken. Most of these processes are in the hands of women and are by no means uninteresting, while the condition in which the women work with artificial sunlight and the latest aerating devices are excellent.

The modern plywood factory is nothing short of a revolution in the prolongation of the life of, notably, the remaining primeval forests on the globe. Each log from each big-sized

tree felled in these forests in the future can be put to its full use by man with the minimum of waste. The annual requirements in logs from any forest will thus be restricted automatically. and the existing amounts of timber still available be spread over a longer period.

Never perhaps in the history of the world has such a prolongation been more necessary, for never has a timber famine in one form or another loomed larger on the horizon. But man's cleverness in producing and perfecting the plywood mill will prove of little use unless the Governments of the chief countries concerned come together, and see that its apparent special advantages are made use of, and are not suppressed by existing vested interests, which have little in relation with the true economic uses and exploitation of the forest.

—*Nature*, Vol. 152, p. 651, *dated December* 4, 1943.

The two extracts published below are from the **Hindusthan Standard**, Calcutta, dated April 9th and April 23rd, 1944.

"Roma locuta, causa finita."—*Ed.*

FLOOD AND AFFORESTATION: SOME CONTROVERSIAL POINTS

By Kamalesh Roy

(*River Physicist, University College of Science, Calcutta*)

After the destructive flood of the Damodar river last year, the public has been vitally interested to know the cause and remedy of the havoc which they have to face so frequently. A number of articles and comments have since been published in journals and newspapers for the benefit of the public.

In course of these discussions some controversial points have emerged, particularly on the relative efficiency of detention dams and afforestation in flood control. Certain forest officers as well as the Central Board of Irrigation have given the first place to afforestation and second place to detention dams. In my previous articles in this paper I pointed out by quoting the authorities on the subject that the claims put forward for afforestation by these persons were highly exaggerated and misleading. But these forest officers have been beaten hollow in these exaggerations by a chemist belonging to the Agricultural Chemistry Section of the Dacca University, who claims that afforestation would suffice for food control and would, in fact, be equivalent to 38 storage dams, each of storage capacity of 15,000 m. c. ft. of water on the Damodar catchment, and equivalent to another 12 reservoirs each of capacity of 22,000 m. c. ft. on the Barakar catchment areas. But such wild statement needs very drastic correction.

These are his very words, "If we can raise by afforestation or other proper erosion-control measures the groundwater table of both the catchments *only by five feet*, it will mean a storage of about 5,85,446 million cu. ft. of water by the Damodar catchment, that is about 38 times the capacity of two dams of 15,000 m. cu. ft. and a shortage of 3,73,570 m. cu. ft. of water (on the Barakar catchment) that is about 12 times the combined capacity of two dams of 22,000 m. cu. ft. . . . ." (Italics are ours).

Theory and Practice.—The arithmetic of our chemist professor is flawless enough, but he forgets, while he proposes to hold 5 feet (or 60 inches) of water by afforestation, that the average annual rainfall on the Damodar catchment area hardly exceeds 50 inches, of which only 43 inches fall in the flood seasons.

So our friend proposes to hold more water by afforestation than what is actually precipitated on the catchment area. *In other words he manufactures water out of nothing by his miracle of afforestation*! Truly enough, the chemists have been called the black-magicians!

But let us suppose that his "five feet" has been a bad slip due to his ignorance of the meteorological conditions of the Damodar areas. He, as well as his forest friends, quote certain laboratory and controlled field experiments to prove that by providing a tract with

vegetal cover, terracing and other soil conservation measures almost all the precipitation can be held up.

It would, however, be more honest to consider the observations on a large number of actual field statistics than to speak on the individually selected out experiments to prove that afforestation holds 97-98 per cent. of the precipitations. These would mislead (and have already misled to a certain extent) the general opinion of the innocent readers. In this connection the observations of the U. S. Civilian Conservative Corps would be valuable: "Our work in the last two years in 141 watersheds throughout the country indicates that the volume of run-off can be reduced 20—25 per cent. through the use of erosion control methods." (*Scientific American*, 154, 326, 1936). This may, therefore, be taken to be the average maximum retardation, and the method includes more elaborate devices like terracing, dyking, etc., over and above simple afforestation.

Cost of Afforestation.—It is however easy to see that the amount of water which runs off these areas depends, first of all, on the slope of the land, on the vegetal cover, state of dryness of the soil and other factors. It is also obvious that we can hold up almost the whole of the rainfall running down the hillside if we terrace the sides and build the dykes all around, and in addition, overlay the surface of the soil with vegetal cover. But would our jungle friends and their chemical ally tell us about the cost for controlling the entire catchment area of 7,200 sq. miles *i.e.*, an area of 4.6 million acres, by these elaborate methods? Would not the total cost come up to astronomical figures? In fact, the whole thing was summed up by an eminent scientist, with whom I had the privilege to discuss the claim for afforestation. His short, pithy remark was, "I see that the measures that are advocated by the afforestation enthusiasts amount to damming everyone of the thousands of hills and elevated areas instead of damming the single river through which the precipitation flows!"

Mr. E. L. Glass did not forget to consider the value of afforestation in preparing his flood control project for the Damodar. He puts it: *"Large expenditure on afforestation seems inadvisable as heavy floods are caused entirely by prolonged heavy rainfall, when the soil is saturated and absorption in forest humus is no more than in open country, though forests do no doubt reduce the smaller floods and the scouring of soil."*

Although every 'school boy' knows that afforestation usually reduces flood crests to a certain small extent, it would be interesting to some of the afforestation enthusiasts as well to note that afforestation, in some cases, may even lead to the increase of flood possibilities. To quote Prof. Barrows, discussing on the Effect of Forests on Stream Flow: "This phase of hydrology has excited much popular interest as well as controversy, opinions going to extremes, on the one side claiming that forests are great natural reservoirs which conserve and regulate the disposal of the rainfall, to appear later as streamflow, while others consider that forests not only decrease streamflow but also increase flood tendencies as well." (*Water Power Engineering*, p. 104, H. K. Barrows, McGraw Hill Co.)

Prof. Barrows has further stated in the same place *"unfortunately, too, advocates of forestry in their zeal for forest preservation often make broad and unqualified statements characterising all forests as water conservators and using this often erroneous statement as their chief argument to justify continued forestation, instead of allowing the worthy objective to stand, as it should, on its own merits."* So everybody knows their trick.

Value of Afforestation.—The value of afforestation on soil conservation has, however, been unanimously recognized. Our chemist friend has once more repeated this, in his last article, out of his irritation. He has also taken the trouble of citing the example of how the Harding Reservoir in California got silted up with eroded soil debris. The Forest Officer from Chaibassa has, in course of commenting upon my article, mentioned

the threat of silting up of the Norris Dam for which the TVA has given special attention on the treatment of the catchment area by afforestation. But these remarks are superfluous, since there has been no controversy on the merit of afforestation in the prevention of soil erosion. I would quote from one of the earlier articles of my own: "It need not be thought that dams will rule out the necessity of afforestation, on the other hand, afforestation on the catchment is a great help to increase the life of a dam." At another place it was quoted from the Report of the Mississippi Commission as follows: "The improvement of the methods of cultivation to avoid erosion and to conserve ground water and the forestation of bare areas, both appear to retard or diminish run-off and are to be *most strongly encouraged* for their intrinsic value. Their effect on floods is too indeterminate to be relied upon for a cure of great evil of mighty flood."

To revert to his last article, the agricultural chemist thought that he had also discovered in my article an important mistake in history, for which he applauded very much in his article. He was shocked to hear the name of De Soto and his party, which, as I mentioned, surveyed the Lower Mississippi River in the 16th Century. Hernando de Soto began his expedition in 1539 and died on 17th April 1542, but his party continued for another year and experienced the heavy flood from 10th March 1543 (for reference see *Improvement of the Lower Mississippi River for Flood Control and Navigation*, Vol. I, published by Mississippi River Commission, Vicksburg). My friend thought that this was an anachronism because he happens to know of some other De Soto who died in 1942. It is just like thinking that since a King George died in 1937, therefore, a statement that King George died in 1727 was a wrong one. But my chemist friend should have had the commonsense that the same name or surname could be borne by different persons living in widely different epochs separated by centuries.

Unscientific Mentality.—The chemist has further given vent to some of his unscientific sentiments. He has wondered that my criticism "did not even spare the views of two experienced forest officers and the Central Board of Irrigation." With due respect to his 'officers' and 'Board' may I say that one should shake off such a mentality if one likes to (or even pretends to) be in the scientific line. Science would not be a science if it calls a Fetish by any other name than Fetish, and I would like to demolish, once for all, the fetish worshipping by our forest officers and their chemical allies, and the arguments with which they try to confuse the unsuspecting public.

In conclusion, I would like to point out that the science of river training is a complicated science by itself, and is not a mere sideshow of the science of agriculture or forestry. The River Science, however, includes the sciences of agriculture, forestry, physics, chemistry, geology, engineering, meteorology, mathematics, and hydrology, etc., in their relevant phases.

AFFORESTATION: HYDROSTATIC PARADOX OF CONTROVERSY

By Prof. A. K. Dutt, M.Sc.

The devastating flow of the Damodar in the last monsoon that had dealt telling blows to the people of Burdwan is still fresh in the memory of the public. Since then one school of thought is stressing greater necessity on removing the causes rather than the consequences of floods alone. And recently the problem of taming the unruly Damodar has been brought to the verge of controversy by our River Physicist of the University College of Science, Calcutta University, as to the relative efficiency of dams and forests in flood-control operations.

"Wit loses itself when dipped in malice." River Physicists are no black magicians: but Dr. Goebbel's 'Doubles' who master the art of

hyperbolical representation, or distortion of facts. We do not know what object he is out to achieve by so grossly misinterpreting the truth to the public. He discovers in the 5-feet (i.e. 60 inches) rise of the groundwater table by afforestation of the Damodar or Barakar catchment something creating matter out of nothing, since the average annual rainfall is about 50 inches there. His knowledge about the most fundamental relationship between groundwater table and the feeding of rivers on the one hand, and between groundwater table and afforestation on the other, is awfully disappointing. A 5-feet rise of the water-table can be attained not in one but in a couple of years depending upon the extent of erosion and the erosion-resisting quality of the flora, just as occurs a drop by 5 feet of the water-table in deforested watersheds. Let alone the 5-feet rise of the groundwater table, if we can raise it only by one foot, it will mean a storage of water about eight times the capacity of a dam of 15,000 m. cu. ft. for the Damodar catchment and about four times the capacity of a dam of 22,000 m. cu. ft. for the Barakar catchment. *But cow's footprints cannot measure the capacity of an ocean!*

The River Physicist is too gelatinous to budge an inch from what he holds about the absorption of rainfall by forests, even though experiments shake this tenet to a fall. To under-estimate the high absorptive power of forest soils established by *numerous field observations* covering over 3 to 5 years, he so long propounded theory minus experiments until recently in his last article he quotes a piece, to his advantage for misinterpretation, from the observations of the U. S. Civilian Conservative Corps. published in *Scientific American*—"our work in the last two years in 141 watersheds throughout the country indicates that the volume of run-off can be reduced 20—25 per cent. through the use of erosion control methods." This gives the average maximum retardation not of forests alone but of all the erosion-controlled methods considered together, since in the same paper we find again: "Through the work of the Civilian Conservative Corps, many areas have been reforested recently. The new forest cover on formerly barren hills and slopes has done 'much' to retard the melting of snow and *prevent a rapid run-off of water.*"

The cumulative influence on rainfall of forests and other anti-erosion measures is masked to a great extent by small-scale reforestation of a badly eroded catchment or by erosion from the run-down pastures and cultivated fields, and as such there can be no permanent control of floods until we have had control over erosion of entire watersheds. I have discussed at some length in my article published in *Hindusthan Standard* of February 13, 1944, as to laying out a certain catchment for optimum utilisation both as regards economic return and erosion—and flood-control. The prosperity of post-war India depends upon the development of her industry inasmuch as she depends upon the development of her agriculture in which forestry and soil conservation will play a great role. Such reclamation work, though effective enough, has caused much disappointment to our River Physicist, who sums up the expenses of the operation amounting to some astronomical figures. But has he ever tackled his brain for a moment to see, that eventually the economic return from such a comprehensive soil conservation scheme, ensuring national security against erosion and floods, will amount to some other astronomical figure much bigger than what stirs his shallow imagination? For example, conservation agronomy aided by both biological and mechanical erosion-control measures increases the crop-yield many times and improves the quality of the crops as well (see works in America and other countries).

Secondly, forests are looked upon not only as great, natural reservoirs that control erosion and floods,—but also as something more that will add, by restoration of fertility, to our present cultivable acreage an immensely large area becoming dry and unproductive, release cow-dung for fertiliser, rejuvenate the dying streams for encouraging fishlife, navi-

gation and irrigation etc., translate into reality the dream of the people to add to the protein content of their food—with the opening up of rich grazing grounds for the cattle and the multiplication of wild-life resources now becoming extinct, and, lastly, but more conducive to the growth of our national prosperity and riches, they will meet our ever-increasing requirements of wood—for newspapers and books, for clothing, for fuel, for explosives, for paints and varnishes and for a hundred other things.

What about the other hollow remark of our River Physicist— only reservoir dams can feed a rapidly dropping hill stream while forests cannot? What about his visit to Chaibassa where he has been invited by Mr. J. N. Sinha to witness the singing throughout the summer months of the little streamlets in the Sadar Subdivision of Singhbhum district where the forests have been preserved since the earliest days of Indian Forestry and then to witness the drying up of streams, a few months after the rainy season, flowing from the deforested watersheds of Dhalbhum subdivision of the same district and Manbhum? Put to his trumps, the River Physicist now embraces the infamous propaganda that the writer ignores the necessity of dams in the control of a mighty flood. I have all along repeated in my previous articles that forests remove the causes and dams the consequences of floods, and in dealing with a mighty flood both will play their respective role—each will complete the other and will be completed by the other. For the reasons already described here and elsewhere, first place is nowadays given to afforestation and second place to detention dams. Let this quotation from my first article published in the *Hindusthan Standard* of January 2, 1944, serve by way of illustration and silence the last beating of the trumpet of the River Physicist. "In addition to the upstream conservation works including suitable erosion-control measures which other countries have adopted to check soil erosion and which would finally reduce the peak of floods by leading to water-storage and soil retention in the now eroding regions, downstream engineering should entail the construction of dams or reservoirs to hold the excessive run-off and also of embankments or dikes in the plains as precautionary measures against any abnormal flow."

One point, celebrated in fables, has clearly emerged from the discussion spun out by the River Physicist and that is, floods, he wants us to believe, are to be regarded not so much as the direct consequences of deforestation as visitations from heaven. Science is rooted in knowledge—that which does not magnify or lessen the worth of a man discovering the truth and of the truth discovered; and if any one working in scientific line appears to be unyielding to what leads to the finding of truth and negatives what he once tenaciously held, he may be let off with Prof. Holmes' 'hydrostatic paradox of controversy.'

"Every real thought on every real subject knocks the wind out of somebody or other. . . You know, that if you had a bent tube, one arm of which was of the size of a pipestem, and the other big enough to hold the ocean, water would stand at the same height in one as in the other. Controversy equalizes fools and wise men in the same way.—and the fools know it."

POST-WAR FOREST DEVELOPMENT

SIR HERBERT HOWARD'S PLAN

The most important problem of post-war forest policy in India is the supply of small housebuilding timber, agricultural timber and fuel, so that the burning of cow-dung as fuel may be stopped, according to Sir Herbert Howard, Inspector-General of Forests, who, at a press conference, explained the note on post-war forest development prepared by him for the consideration of the Reconstruction Committee.

Sir Herbert accepted the estimate that the quantity of cow-dung which was now being

burned as fuel would, if saved, be sufficient to manure 15 per cent. of India's total cultivation.

"If this problem could be solved," he observes in his note, "the appalling poverty which exists among the millions of peasants in India could very largely be removed. Given his supplies of small timber and fuel in his immediate neighbourhood, the fields could be given the easiest and the cheapest manure available and a generally increased prosperity would be the result.

"This is no exaggeration. The general prosperity of India depends largely on the prosperity of the peasants, and this in turn is very largely dependent on having fuel and small timber available in the immediate neighbourhood.

"If sufficient staff was available—consisting of about 70 Rangers and 30 gazetted officers—the provision of such village forests for the use of agriculturists could," according to Sir Herbert, "be achieved in about ten years. Part of the problem was the evolution of a suitable type of oven for the burning of wood instead of cow-dung, and that was under examination.

Next in importance to the provision of fuel was the prevention of floods, erosion and desiccation.

On the positive side, Sir Herbert's plan aims at increasing the area under forest to about 20 to 25 per cent. of the land in each province. That would mean the creation of 100,000 square miles of new forests in British India to be added to 106,000 square miles at present dedicated to forests, representing 13 per cent. of the total area of British India.

The plan, said Sir Herbert, presupposed the provision of trained staff and he had been asked to suggest how the forest service could be expanded and to frame a scheme for doubling the output of the Rangers College at Dehra Dun. Sir Herbert suggested that two circles (comprising two conservators, twenty gazetted officers, 18 rangers and between 5,000 and 6,000 guards) be started at once in each province, costing roughly Rs. 5,00,000 a year per circle.

Replying to the question how far the post-war forest policy was designed to meet industrial needs, such, for example, as the production of newsprint. Sir Herbert pointed out the danger of looking too far ahead in these matters and explained that in England there was a time when attention was given to the growing of certain crooked types of oak suitable for building ships, but by the time that these trees grew to maturity wood had been superseded and steel had come into the building of ships. It would be wise, therefore, to grow trees that could be put to general utility purposes.

Sir Herbert mentioned that although wood suitable for the manufacture of newsprint grew in certain parts of the Himalayas, it grew too far away to be economically transported and used, whereas Canada, for instance, had the natural advantage that these coniferous trees grew where they could be used.

Sir Herbert emphasised that, as individuals, forest officers acted on the basis that forest problems must be solved as all-India problems and not as provincial problems.

—*"The Civil and Military Gazette,"*
Friday, May 5, 1944.

Fig. I

Fig. II

Blister-rust on the stems of **P. longifolia** from the Bhowali Taungya.

Photo: K. Bagchee.

INDIAN FORESTER

OCTOBER, 1944

Pathological Notes : No. 1

THE BLISTER RUST MENACE ON *CHIR* IN KUMAON

The Technical Description of the Rust

BY K. D. BAGCHEE, D.SC.,

(Forest Research Institute, Dehra Dun)

Almost 12 years after the publication of the results of the investigations on the blister rust (*Peridermium himalayensis, Cronarium himalayensis*) infection of *chir* (*Pinus longifolia*)* the writer had the opportunity of visiting Kumaon recently. Inspection was made in Kaligadh, Ganeadeoli and Cantonment blocks of Ranikhet Range, West Almora Division, and in Bhowali, Ninghat, Lariakanta, Gager and Maheshkhan blocks of Bhowali Range, Nainital division, where a survey of the disease was done 12 years ago. The after-effect of the blister rust attack is a very marked one, an everlasting impression being left by the disease on the regenerations.

The regenerations in the Kaligadh compartments are considerably thinned out, leaving patches consisting of 20 to 30 trees of young poles, 25 to 30 years old, on the spurs and slopes, but the depressions where once there were masses of thick regenerations are now practically open lands. In the cantonment blocks the regenerations are attacked by the rust, though the infection is of moderate intensity. In the Bhowali Range, the Ninghat block is but a replica of Kaligadh: in Gager the rust disease is raging high; and in Maheshkhan the infection is of moderate intensity, the advanced growth being considerably thinned out, leaving patches consisting of young poles towards the edge of the depression and along the boundary of the compartments where *chir* is mixed with various miscellaneous broad-leaved species. In Gager several trees between 25 to 30 years in age are suffering from the attack of blister rust. The great number of trees which have escaped chance of infection are either growing on the spurs or slopes or in the ravines where the regenerations are mixed, consisting of *Quercus incana, Myrica nagi, Pyrus pashia, Rhus punjabensis*, etc., and *chir*.

A striking attack of blister rust was observed during this tour in the Bhowali Taungya. The plantation covers 16 acres of terraced land containing line sowings of *banj* oak (*Q. incana*), *chir* (now in sapling stage), *deodar* in dibbles (seedlings) about 50 plants of ash (*Fraxinu* sp.) besides broadcast sowings of *chir* which have germinated *en masse* and are in seedling stage. Out of about 450 plants of *chir* in the sapling stage 173 trees were counted to be bursting with the fructifications of the rust (*figs. 1 and 2, Plate 12*): also 23 dried plants of the last season. The Range Officer informed the writer that he was frequently removing the dried trees from the plantations. There is no future for these remaining saplings as far as one can see; they are all condemned.

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* Bagchee, K. D.—Investigations on the Infestation of **Peridermium complanatum**, Barclay, on the needles, and of **Peridemium himalayense**, n.sp., on the stem of **Pinus longifolia**, Roxb., Part I—Distribution, Pathological Study of the Infection and Morphology of the Parasites.—**Ind. For. Records.** Bot. Sec., Vol. XIV, Part III.

————Investigations on the Infestation of **Peridermium complanatum**, Bagchee, on **Pinus longifolia**. Part II—**Cronartium himalayense**, n.sp. on **Swertia spp.** Distribution, Morphology of the Parasite, Pathological Study of the Infection, Biological Relationship with the Pine Rust and Control.—**Ind. For. Records**, Bot. Ser., Vol. XVIII, Part XI.

The saplings which are apparently vigorous would most certainly be attacked unless the *Swertia* plants are removed from the vicinity. The writer has pointed out before* that it is not a difficult proposition to control this disease by eradicating *Swertia* host and once again it may be emphasised that this is the only known control of destructive heterœcious rusts. In America and elsewhere control of white pine blister rust has been possible by the eradication of perennial woody plants like the currants and gooseberries, and of wheat rusts by removal of berberry, which are the alternate hosts. The roots of currant and berberry bushes are very difficult to kill or remove from the forest and agricultural land; expensive chemical sprays have to be injected into the root-system to exterminate these hardy plants. In case of *Swertia* extermination should not be at all difficult. The terraces will be covered with *Swertia* after a few showers of rain. Three weedings of this host between July to September up to a range of 200 yards from the edge of the plantations for three successive years will safeguard the future of the young seedlings.

Technical Description of Cronartium himalayense Bagchee sp. nov., synonyms, *Uredo opheliae* Sydow (27), *Peridermium complanatum,* var. *corticola,* Barclay (5), *Peridermium himalayense* Bagchee (3):

Pycnidia caulicolous, under phelloderm, small, inconspicuous, scattered, forming minute blister-like swellings, exudation orange-yellow, mixed with resin or sweet fluid; spores hyaline, colourless when single, light-yellow in mass, ovoid to ellipsoid, averaging 4.2×2.5 μ.

I.—*Aecidia* caulicolous, large, prominent, usually separate sori, on small branches elongated or short protuberating sacs, on trunks of trees occasionally confluent, 4 to 12 mm. long with 2 to 6 mm. diameter, colour orange-yellow; spores orange-yellow, obovoid to elliptical, averaging 24.7×17.4 μ, outer wall coarsely verrucose, epispore (including tubercles) measured from end view 3 to 3.75 μ, measured from side view 3.5 to 4.5 , *peridia* thick, persistent multi-layered, 3 to 4-celled, ridged and furrowed on the top and finally grooved laterally, rupture by irregular cracks on the top of the dome, long and short dimensions measured from the middle of fully developed *peridia* averaging 27.9×18.2 μ, external wall of the outermost peridial cell including tubercles 5.2 μ; filamentous outgrowths from the inner wall of the peridium, length 2 to 4.5 mm.

On *Pinus longifolia.*

II—*Uredosori* hypophyllous, spreading on to the stem and other green parts, scattered to sub-gregarious, hemispherical, colour orange-yellow to rusty-yellow, 150 to 200 μ in diameter, dehiscent by a central pore which opens from the stomatal region at first and finally extends outwards; *peridium* evanescent, delicate almost indistinguishable in mature sori, cells elongated to obovoid averaging 20.5×14.5 μ; spores orange-yellow in mass, ovoid or ellipsoid, averaging 22.5×16.5 μ, wall light-yellow to light-orange, 2 to 3 μ thick, sparsely and sharply pointed.

III—*Teleutosori* hypophyllous, finally spreading on to stem and all green parts of plants, cylindric, 750 μ long, 80 μ thick—colour walnut-brown; spores light brown, cylindrical to polyhedral or occasionally spindle-shaped, corners rounded or obtuse at both ends, averaging 37.5×18.5 μ, wall smooth, thickness .08 to 2.5 μ; sporidia delicate, hyaline, globoid, 5.5 to 6.5 μ.

Hosts.—Swertia alata, Roxb. West Almora, East Almora, Naini Tal, Garhwal and Chakrata divisions and the Mussoorie Hills.

Swertia angustifolia, Ham. West Almora, East Almora, Naini Tal and Garhwal divisions and the Mussoorie hills.

Swertia cordata, Wall. West Almora, Nainital, Garhwal and Bashahr divisions and the Mussoorie hills.

* Vide footnote on the previous page.

Cronartium himalayense, Bagchee, sp. nov.

Syn.: **Uredo opheliae** Sydow (27), **Peridermium complanatum,** var. corticola Barclay (5), **Peridermium himalayense** Bagchee (3).

Pycnidia caulicola, sub-phellodermate, minuta, inconspicua, dispersa, parvulos pustulae instar tumores efformatia; exsudatio aurantiaco-lutea, cum resina vel dulci liquido mixta. Sporae hyalinae, singillatim incolorae, acervatim tenuiter flavae, ovoideae vel ellipsoideae, mediet. 4.2×2.5 μ magnit.

I—Aecidia caulicola, ampla, eminentia, plerumque soris separatis, in ramiculis elongata vel brevium saccorum instar prominentia, in arborum stipitibus interdum confluentia, 4—12 longa, 2—6 mm. diam., colore aurantiaco-flava. Sporae aurantiacoflavac, obovoideae vel ellipticae, mediet. 24.7×17.4 μ, pariete externo crasse verrucoso, episporio (inclusis tuberculis) mensurato ex apice 3-3.75 μ, lateraliter mensurato 3.5—4.5 μ. Peridia crassa, persistentia, multi-seriata, 3-4 cellulata, apice sulcata, lateraliter minute canaliculata, rupta irregularibus fissuris in parte superiore, longa et brevi mensura desumpta ex medio peridio plane evoluto mediet. 27.9 — 18.2 μ, pariete externo extremae cellulae peridii (tuberculis inclusis) 5.2 μ, pilis emergentibus ex interno pariete peridii, longit. 2-4.5 mm.

In **Pinus longifolia.**

II. Uredosori hypophyli, extendentes usque ad truncum et alias partes virides, dispersi vel subgregarii, hemisphaerici aurantiacoflavi vel ferruginei-flavi, 150-200 μ diam., dehiscentes per porum centralem, qui primo aperitur ex regione stomatica, deinde extrorsus extenditur. Peridium evanescens, gracile, haud facile manifestum in sori maturis. Cellulae elongatae vel obovoideae, mediet. 20.5×14.5 μ. Sporae aurantiacae acervatim, ovoideae vel elllipsoideae, mediet. 22.5×16.5 μ, pariete tenuiter flavo vel aurantiaco, 2-3 μ, crasso, acute atque haud dense mucronatae.

III. Teleutosori hypophyli, demum truncum atque omnes partes virides plantarum invadentes, cylindrici, 750 μ longi, 80 μ crassi colore castaneo-brunnei. Sporae tenuiter brunneae, cylindricae vel polyhedrales vel interdum fusoideae, angulis rotundis vel obtusis utroque apice, mediet. 37.5×18.5 μ, pariete levi, 0.08 — 2.5 μ crasso. Sporidia gracilia hyalina, globoidea 5.5—6.5 μ, magnit.

Occurrit in Swertia alata Roxb., in regionibus West Almora, East Almora, Naini Tal, Garhwal atque Chakrata, atque in Montibus Mussoorie.

In **Swertia angustifolia** Ham. in regionibus West Almora, East Almora, Naini Tal atque Garhwal atque in Montibus Mussoorie. In **Swertia cordata,** Wall. in regionibus West Almora, Naini Tal, Garhwal atque Bashahr atque in montibus Mussoorie.

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The writer is indebted to Fr. Santapau, S. J., Professor of Biology, St. Xavier's College, Bombay, for kindly rendering the diagnosis into Latin.

INFLUENCE OF FORESTS ON RAINFALL

By O. M. Martin

(Commissioner, Post-war Reconstruction, Bengal)

There has beeh a lot of careful research into this subject. There has also been a lot of confused thinking, and hasty conclusions have been drawn, both for and against afforestation. The general principles, however, seem clear, and it may be useful to try to restate them and to add a few observations of my own.

1. Forests act as a sponge. They hold the rainfall and in the first instance prevent it from reaching the ground at all. This action is a feature of all vegetation covering. To what extent any particular vegetation cover absorbs the initial rainfall is a matter of fact to be tested by experiment. Grass and bushes may be a better sponge than trees, especially if the trees prevent undergrowth. Thick undergrowth is certainly a better covering than sparsely distributed trees, without undergrowth.

2. It follows from the above that forests increase evaporation. The light showers which, without trees, would refresh the grass and dampen the soil, are caught by the leaves and speedily evaporated. The effect of this is to prevent extremes of climate, as the evaporation keeps the temperature down. This tends to prevent heavy local downpours by reducing the number of violently ascending and descending currents of air. It also

tends to increase rainfall as a whole over a large area, owing to increased humidity. This effect (of increasing the rainfall) cannot be local. It can only be noticeable in large areas and takes effect in the *direction of the prevailing wind*. The action of forests in preventing heavy downpours, on the other hand, is distinctly local. The distinction between local and widespread effects is not usually made. It is of extreme importance, however.

3. The effect of forests on rainfall is much more complicated in the hills than in the plains. Darjeeling district requires careful study in this connection. The lower forests in the district have much less undergrowth than the upper forests. Undergrowth is very dense in the upper valleys, in the monsoon zone, even at 14,000 feet. The main reason for this is mist, i.e., not simply rain, but air super-charged with moisture. A large part of this moisture comes from the evaporation in the lower forests. You can watch the mists rise from the wet forests below, as soon as the sun strikes the valley. Part of this moisture is at once deposited, very gently, in the upper forests. The amount of deposit depends to a large extent, on the nature of the trees. Some trees condense the mist and water in their own roots. *Cryptomeria* is particularly good at this. During a sudden shower, you can stand for fifteen minutes under a *Cryptomeria* tree and keep dry. But a few hours' continuous mist without rain reverses the process. You will remain dry in the open, while under the *Cryptomeria* tree there will be continuous light rain, owing to the condensation of the moisture on the small rough needles of the tree.

The net result of this action and interaction between the upper and lower forests is that rainfall tends to be more continuous and more gentle. This action goes on *even in the monsoon*. I was watching it quite recently, at the end of June.

4. It is well known that in desert climates, light rainfall is rare. When rain does come, it usually takes the form of a deluge. Forests tend to make rain more frequent and more gentle. This effect is obvious only over large areas. The effect of destroying a few square miles of forest may not be obvious at all. But when denudation takes place on a large scale, the effect is usually disastrous. The disaster does not necessarily come to the area denuded. The worst effects are *likely* to take place elsewhere *in the direction of the wind which prevails during the rainy season, and just after the rains*.

5. The effect on subsoil water (and therefore on springs) follows from the same principle. The Darjeeling Municipality will be able to give interesting figures correlating rainfall with the discharge of springs during the dry season. The Municipality knows quite well that if the Tiger Hill forest were to be denuded, the municipal water-supply would fail. The process of soaking into the subsoil is what feeds the springs, and this process goes on very very slowly during the period that the top soil is soaked. It proceeds for a long time after the cessation of the monsoon, because the forest protects, from evaporation, the super-soaked top layers of soil. No amount of heavy rain over a short period will adequately feed the springs. The sponge (*i.e.*, the forest) must hold the water and let it trickle through the sub-soil over a period of months.

6. Another place you can study the effect of disforestation on springs is Chittagong and the Chittagong Hill Tracts. The reserved forest is full of small perennial springs, but where the forest is cleared, not even the thickest growth of grass prevents the springs from drying up in the dry season. One reason for this is that the sun dries up the top layers of soil as soon as the rain stops.

7. There is another reason too. The roots of the trees make channels for water, through which the sub-soil is fed. This seems to account for the remarkable fact that although the roots take moisture from the subsoil and give it out into the air throughout the year, still they preserve the subsoil water. This action is most noticeable when the soil is stiff clay and is less noticeable when the soil is sandy and porous. What seems to happen is

that the roots of the trees follow the easiest course down, very often following the burrows of earthworms, to start with. Then the root is stopped. It thickens, straightens and creates a passage for itself by slightly splitting the clay, just as a *peepal* tree will demolish a masonry building. This splitting and cracking action is part of the regular growth-mechanism of trees and is not peculiar to the *peepal* and its kind. It has a very far-reaching effect on vegetation, climate and soil economy.

Para. 7 is a theory of my own. I must confess it is not properly verified, but may be worth recording.

SOME REQUIREMENTS OF POST-WAR FOREST POLICY IN THE C.P *

BY V. K. MAITLAND, I.F.S.

(Conservator of Forests, Eastern Circle, C.P.)

Foreword.—The note on Post-war Forest Policy was originally prepared by the Conservator of Forests, Eastern Circle, Central Provinces, as a letter to the Provincial Government.

It was felt that the views expressed by Mr. Maitland would be of interest to the readers of the "Indian Forester" and permission was obtained from the Government of the Central Provinces to publish the note with a few minor corrections.

Sir Herbert Howard, Inspector-General of Forests.

"Sir George Stapleton, of the British Ministry of Agriculture, holds that man's attitude towards the problem of erosion is the supreme test of his wisdom."—

—The Hon'ble Sir Jogendra Singh, in his Address at the 1944 Convocation of the Indian Forest College.

1. *The Post-war Reconstruction Policy Committee (No. 5).*—The recent Policy Committee (No. 5) on Post-war Reconstruction in respect of Agriculture, Forestry and Fisheries which was held at Simla on the 26th of June, 1944, and on subsequent days, and which I attended, has detailed certain matters in the form of resolutions which, it is intended by the Centre, should provide the basis of post-war reconstruction planning. The resolutions apply to India as a whole but with particular force to those provinces which, unlike the Central provinces, have a far lower proportion of tral Provinces, have a far lower proportion of (20—25 per cent.). It should not, however, be assumed that the C.P. is not affected by these resolutions or by the measures which will derive from them. On the contrary, the C.P. is not devoid of forest problems, nor is the necessity for immediate action absent.

2. *Short and long-term planning in relation to the present requirements.*—It has, I am aware, been suggested that our attention should be focussed on immediate requirements affecting the period of the next five years. It is not impossible to make a list of schemes which might be hoped to occupy the Forest Department for the next five years, but it is inescapable in the profession of forestry that we must plan ahead for a very much longer period than that. It is also essential that we should be provided with the necessary staff before we can undertake even schemes to be executed in the next five years. It is, therefore, clear that it is impossible to attempt to divorce long-range planning from short-range planning in forestry, whatever may or may not be possible in agriculture where the Government is faced with an urgent, in fact an immediate, necessity for the production of large harvests this year and in the next five years. No one questions the wisdom of canalising effort to that end now, and in the immediate future, in respect of agriculture—but I wish to make it clear that in forestry, which reaps its crop in a period measured in term of generations of men rather than in years, we can do nothing in a five-year

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* The views represented are entirely those of the writer, and should not be interpreted as being necessarily those of Government.

planning scheme which will affect useful production within that period. The Forest Department is concerned with two things now. One is the maintenance of the exploitation pressure on its forests so long as the war demand exists. The other is the immediate provision of the necessary foundations for the buildings of the post-war edifice. The definition of forest policy and the provision of staff to execute it amount to the laying out of those foundations.

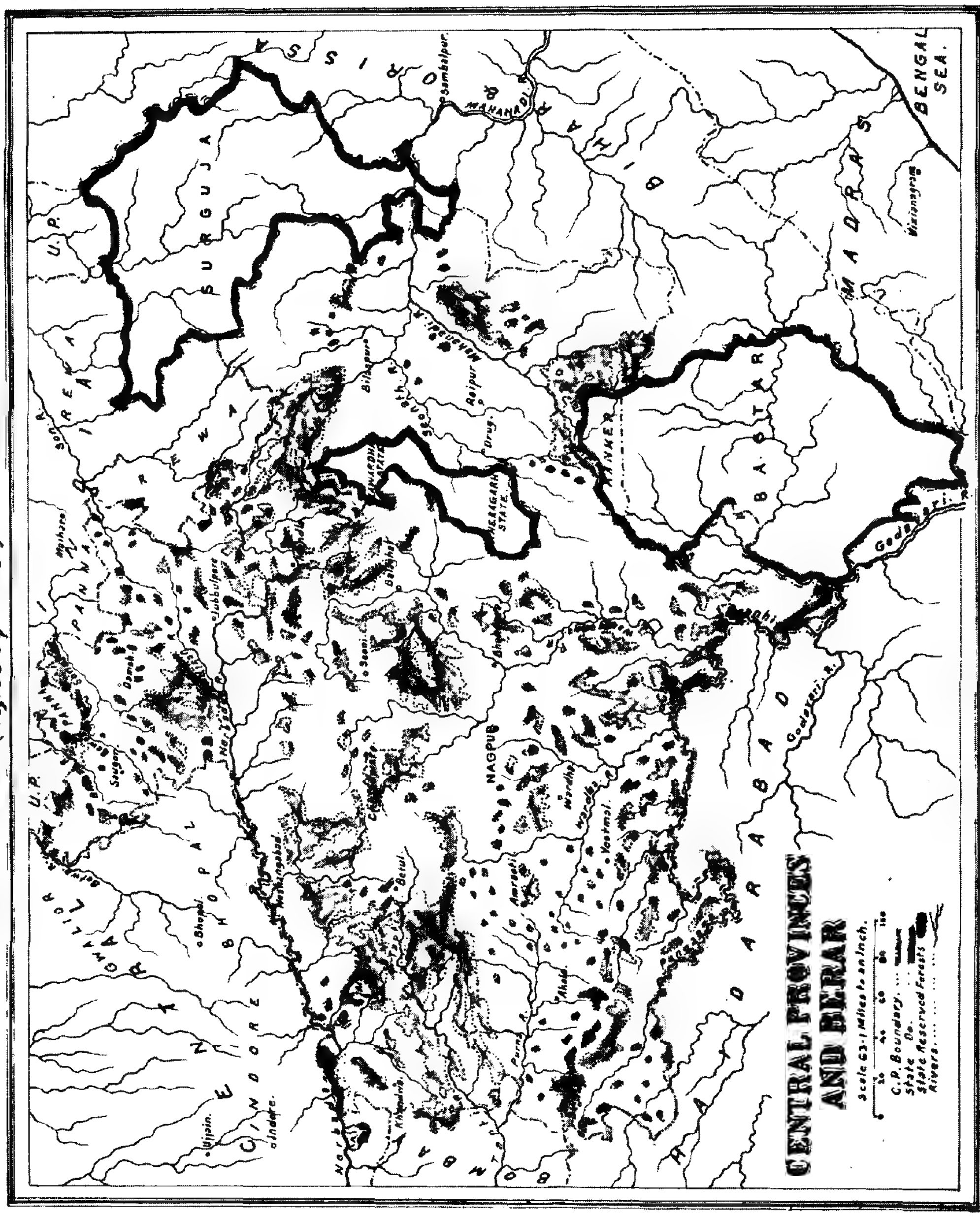
3. *The Resolutions of the Policy Committee.*—The resolutions concerning forestry which were passed at the Policy Committee meeting at Simla are appended to this note. It will be observed that a Central Land Utilization Board is to be set up. It will also be noticed that the Centre suggests that the provincial Governments should acquire legislative powers in respect of certain matters and that the provincial Governments will be asked to communicate views, criticisms and concrete suggestions in respect of these resolutions within a period of three months (*i.e.*, by 1st October). It will also be seen that certain essential surveys are necessary in each province and that expansion of the Forest Department is bound to come even in the Central Provinces. The particular attention of the C.P. Government has been invited to resolution 9 (*b*), subpara. 4. I wish to deal with this last matter now in greater detail. It is the first one to be tackled —being the most fundamental of all, *i.e.*, Provincial Forest Policy.

4. *The Highlands of Central India.*—It may be emphasised that the C.P. has (*vide map in Plate 13*) almost exactly one-fifth of its total land area (which is 98,559 square miles) under State forest and another large fraction possibly also one-fifth of its total land area under Private forests in one form or another or as potential forest land (*i.e.*, uncultivated land more suitable for growing trees than for growing crops). The total area of land to be considered is so vast (40,000 square miles) and forms so large a proportion of the total area of the province that its fate cannot be dealt with by a series of notes provided on the one hand by scattered officers of the Forest Department and on the other hand by semi-technical officers of the Revenue Department. The whole direction and planning of the control of nearly one half of the land of the province is too important a thing in its effect on our provincial economy (and indeed of the land use problems of India generally as this land includes the headwaters of five great river systems draining N.E.W. and S.) to merit anything less than the special attention of the highest administrative authorities in the province. If ever there was a watershed area this is one (*vide* map in *Plate 14*) and in this connection the following remarks from America may be quoted:

" . . . managers of mountain watershed lands, in order to safeguard the public interest, must maintain the broadest possible outlook. They must struggle to evaluate and integrate properly all uses and services of the land so that maximum benefits will be derived; and they must particularly avoid permitting any subordinate use, no matter how striking locally, to expand at the expense of broader, more important aspects of land use such, as watershed service." (*Indian Forester* June, 1944, page 204—extract from *Journal of Forestry*, Vol. 41, No. 9, dated September, 1943.)

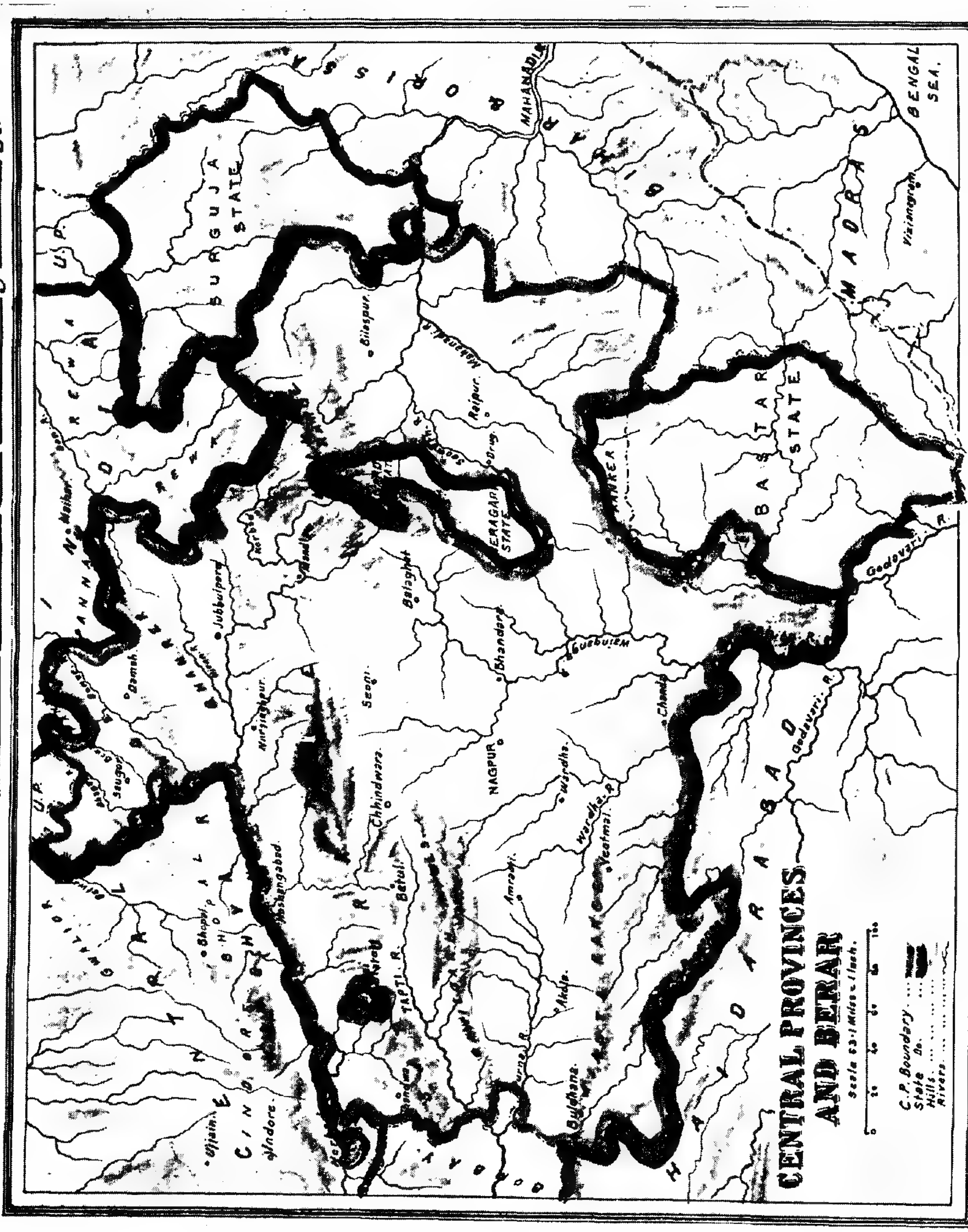
5. *A Local Forest Policy.*—The first thing we have to do is to set up a Forest Policy Committee in the C.P., which must determine the permanent forest policy of this province and specify it with the full approval of Government. Having obtained approval of its recommendations it must present them to the Centre not as an opinion of desiderata but as the settled forest policy of this Government. This C.P. Forest Policy Committee must, therefore, be set up immediately. It must be charged with the responsibility for examining our position in the light of the resolutions of the Simla Policy Committee meeting. Having clarified the C.P. forest policy *vis-à-vis* the old Government of India forest policy it must give definite start to the short-range and long-range planning required by the various resolutions. It cannot be too clearly emphasised that we shall fail in our duty in respect of all-

State Reserved Forests of the Central Provinces.
(19,439 Sq. Miles.)



Note:- The (approximately) 20000 Sq. Miles of Private Forest etc. are not able to be shown. Forest areas in the States which are considerable (atleast 50% of their total area) are also not shown.

Hill and River systems of Central Provinces and surrounding territory.



Northerly drainage by.— Betwa, Dhasan, Bewas, Sonar, Son, etc. to Ganges.
Easterly drainage by.— Seonath. etc. to Mahanadi.
Southerly & Easterly drainage by.— Wainganga, Wardha, Penganga, Pranhita, etc. to Godavari.
Westerly drainage by.— Purna. etc. to Tapti.
Westerly & Northerly drainage by.— Nerbada.
Main River Sources in the area are :— Nerbada, Mahanadi, Godavari, Tapti.

11.8.44
Draftsman Forests, Eastern Circle. C.P.

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Conservator of Forests, Eastern Circle. C.P.

India land-use planning as well as in respect of the internal economy of the province if we do not formulate and clarify our ideas and hammer out a sound forest policy acceptable to the Central Land Utilization Board *immediately*.

6. *Political Implications.*—I have urged that constitution of the C.P. Forest Policy Committee should be decided as soon as possible by a meeting of the Government and it is expected that the committee should meet in August and again in September so that before the three months' period indicated by the Simla meeting is over we shall have worked up something concrete which has Government's complete and considered approval. Although its final decisions may have political repercussions, they will deal with technical facts and it is for Government to make up its mind whether it proposes to come down on the side of *laissez faire* or of "reconstruction." Such repercussions will be shared particularly by all "Section 93" provinces. It is suggested that they be dealt with like other post-war problems of a political nature, when and not until, they arise. Like most bugbears they will shrink as soon as tackled determinedly. The Policy Committee may be able to meet at less frequent intervals afterwards once the present urgent requirements have been satisfied. This point may be decided later. It has not been proposed to obscure the direct request for the setting up of the Committee by enlarging on the various aspects of all the detailed matters which must be dealt by it. Some of the most important specific subjects to be dealt with have, however, been listed and material has been collected. Space forbids me to go into them here. All these subjects, together with the subjects mentioned in the Simla Policy Committee resolution will, it is hoped, be taken up at the first meeting. It has, however, been considered necessary to offer some remarks on the more basic matters even at this preliminary stage in order to convince Government, if possible, or, if necessary, of the paramount importance of taking action as indicated in para 5. At the risk of providing the more enlightened readers of this journal with what they may regard as glimpses of the obvious I repeat them here.

7. *Indian Forest Policy and the C. P.*—Forest Policy expresses the intention or the wishes of the owner of the forest concerning the use the owner makes of his forest or forest land. When the ultimate owner of the State forest in this country was the Government of India, the Government of India forest policy was defined. It was defined in the year 1894 [Circular No. 22-F, Government of India, dated 19-10-1894, and it is contained in the *Forest Code*, 7th Edition, Appendix V]. That document, I may say straight away, has evidently not been studied sufficiently carefully by Revenue or Forest Department officers in this province in the past. It was notwithstanding—the first forest policy ever enunciated in the British Empire, and it remains to day a comprehensive and adequate one giving clear expression to absolutely sound technical principles. It is, however, only a statement of principles and, as I hope to show later, it is necessary to expand it as a more specific and "Political" policy on account of the peculiarities of the present administration. The only serious defect which has been found in its application in the C.P. has been in respect of laxity in its provisions regarding the provision of grazing facilities in Minor Forests. That weakness has been pointed out and fully discussed in the publication *Fodder and Grazing in the Province* by the Silviculturist and the Assistant to the Director of Agriculture in 1941. It is significant that when the Forest Department and the Agriculture Department deal with a problem jointly, we get some really useful recommendations.

8. *Statement of Policy—the Duty of the Owner.*—The introduction of Provincial autonomy involved a change in ownership, and as the C.P. Government is now the real owner of its forests and forest land, it must either formulate a new forest policy (acceptable, of course, to the Central Land Utilization Board), or, must indicate its acceptance of the old Government of India forest policy with any minor modifications it desires. My

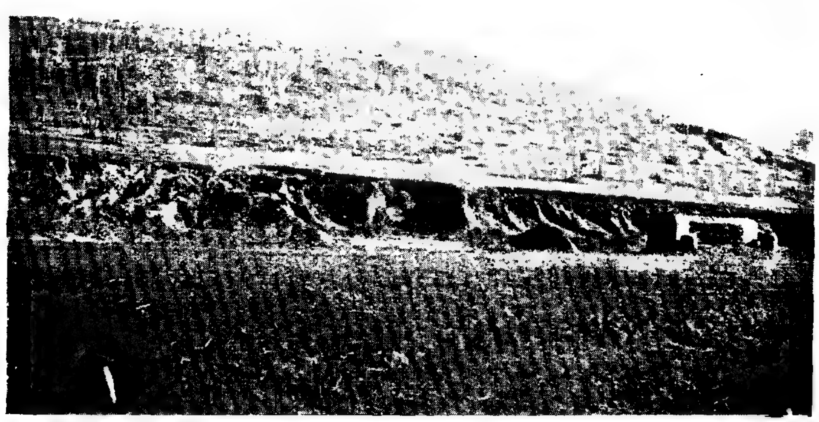
recommendation is that C.P. Government should formally adopt the old Government of India policy as its own but should amplify it and modify it in respect of (*a*) the particular weakness, as regards the grazing problem in minor forests to which I have referred, (*b*) the relative importance of revenue production which I deal with below and (*c*) the vital necessity of integrating it with land use agricological and political developments which have taken place since 1894 or may be expected in the near future. Although the above might not appear at first sight to be a very serious matter, the fact is that definition of its forest policy in the light of the old Government of India policy on the one hand and the resolutions passed at the Simla meeting on the other will involve change in this Government's attitude towards forestry—considerable change—and change for the general good.

9. *Forest Policy in the Empire.*—It has been stated that the British as a nation are devoid of "forest sense." This is, in my opinion, not only a substantially correct statement but one which indicates the root cause of many of the troubles of the forest administration in this country and in fact in the British Empire generally. The same remark is being made with greater emphasis in technical journals frequently now (*e.g., Empire Forestry Journal*, Vol. 22, No. 2, 1943). The British necessarily, from the very circumstances of their history, have not been characterised by the possession of this quality. "Forest sense" is, it may be noted, quite distinct from the national and typically British love of individual trees or parks. The work of the game warden, the land agent and the timber man may be understood, but the job of that branch of planned land use which covers the science of forestry has been appreciated less in Britain than any of the western countries. The very fact that the only forest policy which existed in the whole British Empire until about 20 years ago was the Government of India forest policy illustrates this assertion. It is worthy of note that our one firm anchor—the Government of India forest policy—was devised under the guidance of two eminent Germans, *viz.*, Dr. Brandis (Forestry) and Dr. Voelker (Agriculture) exactly half a century ago. (Another example of the co-ordination of Forestry and Agriculture producing important results.) Forestry appears to have been appointed as the "handmaid of agriculture" from that time (and one is tempted to enquire whether she is now about to be made an honest woman for the sake of the growing child, "Land Use"!).

10. *The British Background.*—British administration is influenced by the British background. Britain is not even representative of the continent of Europe. It is a land of temperate climate, of green soil cover, a balanced or stabilised agricultural practice and a long accepted dependence on imports of raw materials. Finally, it is a land where any state control of land use has run counter to ancient tradition and practice. But the British background itself is changing as, in the opinion of many people now, individualism has been allowed to go too far, *i.e.*, to the point where the safety of the community is endangered. A certain measure of state control has been inevitable in industry, and is now becoming inevitable in the realm of general land use. Extension of state control of land use means extension of state forestry—in Britain to a minor extent—but in India and the whole of dry tropical belt—to a very great extent. If India needs classic examples of disaster caused by lack of state control over the operations of the individual (or group of individuals) on the land—she can find them in America or here in her own "bad lands." She will not learn much from Britain—for the reasons mentioned above. (What that country can supply, of course, are some classic examples of the effect of uncontrolled individualism in industry, town development and ribbon building but we are not dealing with those subjects). The causes and effects of these disasters are being tackled now in no uncertain way in America, and there is no reason why India should not take advantage of the terrible lessons learnt. The British

Fig. I

Fig. II



Soil erosion in C.P. A private forest ruined by felling, lopping. and unrestricted grazing.

administration in most parts of the Empire has provided the necessary background for effective land use planning, *i.e.*, peaceful conditions, a comparatively square deal to the citizen, law and order. It has also wisely and in many directions recognized the fundamental importance of agriculture—but having done all this it has failed to take the final and most effective step, *i.e.*, to plan land use on general lines. Forestry has also been regarded as a useful means of producing revenue from waste land or undeveloped land in general and exploiting timber reserves. The main function of forestry which is, in the dry tropics particularly, the shield of agriculture and guardian of the soil fertility of the country, has not been fully recognized by such governments as that of this province. There is no erosion problem in Britain—there is no desiccation problem and no soil-water conservation problem as we understand such things here. British-trained administrators in this country should, therefore, read up the literature on these subjects before making decisions. If anyone reading this particular note has not yet perused Dr. Gorrie's publication *Soil Erosion in British Empire* (Imperial Council of Agricultural Research. Vol. IV, Part II of March 39) he should do so at once in order to grasp the elementary facts of the case. Even a casual perusal of the current technical or even popular literature on the subject of soil conservation will show that the principles formulated in the Government of India forest policy must be observed if we are to preserve the fertility of the soil which is the main economic asset of the people. Until our administrators and politicians study this literature and fully grasp its importance it is most dangerous to leave those principles unexpanded and not translated into more definite and specific rules for local application.

11. *Soil Erosion in the C.P.*—It is unfortunate that an impression has been created that there is practically no erosion problem in the C.P. Those who think that "It can't happen here" have evidently not noticed the widespread occurrence of the conditions exemplified in the accompanying photographs of a private forest in the C.P. (*vide Plate* 15). Soil erosion has already begun, due to the steady destruction of private forests everywhere and to the heavy grazing incidences allowed in minor forests to which I refer later in this note. Desiccation, an even more insidious process, and one less easily recognized here, has of course been proceeding apace for many years. We have not yet in the C.P. created the gullied wastes of Gwalior or of the Etawah district of the U.P.—the ravined foothills of the Himalayas and Siwaliks or the desert conditions of Sind, but the first processes in the creation of such "bad lands" have been started and they will gather way with spectacular momentum so long as such a large proportion of forested hills remains, without effective control, in private ownership. Perhaps the most striking examples of the necessity for early action are provided by the surroundings of the Sheonath and other Mahanadi tributaries in the Bilaspur and Raipur districts. The former district contains some 600 square miles of Government forest and about 3,000 square miles of private (*zamindari*) forests. Erosion has begun in the *zamindari* (whether under the Court of Wards or not) on account of uncontrolled exploitation, lopping, heavy grazing and, in more remote areas, the practice of allowing shifting cultivation to be combined with grazing and even ploughing. (In passing it may be noted that the correct regulation of shifting cultivation here would appear to be to restrict it to bamboo areas exclusively, to allow it to "shift," to prohibit ploughing or disturbing of the soil and the entry of cattle. These measures, it will be observed, will conform with the ancient original technique embodied in aboriginal tradition which abhorred the use of any instrument but the axe, which insisted on bamboo areas, which regarded the "Laceration of the breast of Mother Earth" with disapproval, and which favoured abandonment of the area once two or three crops had been reaped—for 20 years or so, *i.e.*, a generation). As for erosion effects in the valleys of our

larger rivers, I noted as follows during a tour in a portion of the Nerbada Valley in 1941:

"These agriculturists once in possession of some of the finest double-cropping land in the Province were evidently turning to the keeping of goats as a substitute for agriculture. This locality and others along the Nerbada basin require an erosion survey and drastic regulation, particularly regarding the keeping of goats, as the present situation is alarming, and the prospects for the immediate future most serious. The usual signs were everywhere evident: (*a*) expensive road culverts being eroded to their foundations, herds of goats wandering about among stunted bushes, fields invaded by gullies, large areas eroded to underlying rock with no soil at all and long since abandoned by cultivators. Villages are now situated far from their remaining fields. The damage is progressive, cumulative, and may soon be irreparable over a very large area, once remarkably valuable."

It would be more correct to speak of such cases as erosion disasters rather than erosion problems but sufficient has been said to show that even the existence of the ideal proportion of Government forests in a province will not of itself confer immunity from these problems.

12. *The Value of Protective Land.*—Even were there no serious erosion effects in the C.P. we should still be required to see that such a problem did not arise. We should still have our present responsibility to neighbouring provinces on account of our control of headwater lands. Let it be quite plainly stated that Central India will be reduced to a desert and its people to the conditions of the inhabitants of Libya (once the granary of ancient Rome), if conditions of peace continue to operate without the safeguard of proper and planned state control of protective land. The people themselves and most of their popular representatives are not aware of this fact. "Scrub forest of little value," to use a significant C.P. expression, may actually be of greater indirect value to the community than the finest timber forests, when the former is on a hillside, and the latter on a level plain. Political and popular and official opinion need to be educated on this point, and reminded of "how great events may spring from small causes."

13. *Classification of Government Forests into Tree Forests, Scrub Forests, Pasture Lands, etc.*—I have referred already to the danger of leaving fundamental principles of forest policy to local interpretation—under our administration. The C.P. Government has, twice in the last 30 years, by prescribing classification of State forests by "general type," instead of by function involved itself in a serious departure from the sound principles laid down in the Government of India forest policy. (A clear explanation of which will be found in Sir Herbert Howard's *Note on Post-War Forest Policy* of 1944). Senior forest officers appear to have adopted a supine attitude due perhaps to the habit of acquiescence or to the loss of nerve sometimes induced by the imminence of retirement. Whatever the reason, it did little to protect or to explain things properly and the files show that few forest officers took a firm stand or even perceived the danger of what was being done.

14. *Results of the Demand for Grazing Ground.*—About three million cattle graze in the Government forests of the C.P. and the nominal value of that grazing at the so-called "commercial" rates which are really far below commercial figures would be about Rs. 23 lakhs. Concessions, however, in the form of free, privileged or ordinary rates apply to two-thirds of these cattle, and the actual grazing revenue is about 10 lakhs only. The Government of India general classification of forests placed protection, local demand, provision and revenue production in that order of priority. State forests in the C.P. were, however, classified in 1915 and again in 1931, according to so-called type and the degree to which they were subjected to local demand. The latter classification was made with the sole object of meeting an unsatisfied demand for grazing ground. I believe that this was short-sighted and definitely contrary to the Government of India forest policy, being based on elementary misconceptions of the real value of those forests which may have

little intrinsic but great functional value. It has created the cumulative effect of a vicious circle set up by too heavy grazing on inferior pastures. It has never been explained why poor soils were assumed to be able to stand heavier grazing than better soils. Possibly poorer type forests were regarded as a wasting asset. If so, it is clear that their erosion control value has been very largely ignored. A fringe of ruined pastures marks many of our reserves and this fringe is steadily marching inwards as the maximum incidences permitted in the four categories of forest are:

A.—Tree forest—

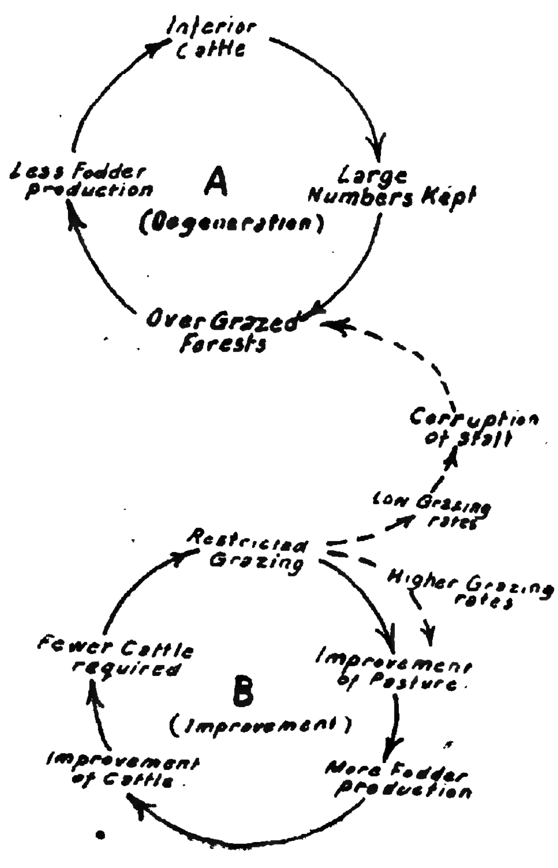
I—Moist type (11.9 per cent. of total) 4 acres per animal.

II—Dry type (44.0 per cent. of total) 3 acres per animal.

B.—Scrub forest—

I—Pasture forests (25.1 per cent. of total) 1 acre per animal.

II—Open pastures (7.3 per cent. of total) No limit.



C—Miscellaneous—

Grass Reserves, village sites, etc. (11.7 per cent. of total) No grazing.

The type of process represented by **A** (*vide* diagram in the first column) has to be changed to that at **B** wherever our pastures are degenerating. The dotted arrows in the diagram connecting the two circles refer to the fact that a combination of restricted grazing and *low rates* is administratively difficult as it leads to corruption of the staff and non-restriction of grazing in actual practice. When grazing is restricted and rates are high the licensees themselves act as *chowkidars* to keep out cattle not paid for.

As the C.P. State forests contain all types of forests closely intermingled, the Government of India very broad classification can only really be applied by leaving the forest officer alone to deal with each particular area according to its merits. It was, therefore, unsound to attempt to classify forest in a general way according to type and then to lay down a fixed incidence for each so-called type. A far safer practice is to provide a flat grazing incidence for all our forests which will allow even the poorest pasture to recover and maintain its productivity. Wherever the pasture produces more grass than is grazed down, fodder cutting should be encouraged. General grazing questions such as simplification of rates, the relation between privilege and demand and the possibility of more frequent revision of (simplified) rates will be considered. The following extracts are worth recording in this connection from the report by the Special Revenue Officer on the Working Plan of the Bilaspur Forest Division—which report suggested an ingenious practical and logical method of applying the principle of progressive restriction. The suggestions made were (in my opinion) unfortunately not adopted when made in 1935:

"*Grazing Settlement — Introductory.* — Whatever the original intention of the fixing of privilege and ordinary rates for grazing, they have developed into a subsidy to cultivators who keep cattle in the neighbourhood of

the Government forests. There is no particular reason why such a subsidy should be given to cultivators and not yet withheld from professional graziers. Both are working under the same economic laws and both are the producers of important articles of food. It might be argued that since there is far more difficulty in getting pure *ghee* and milk, than in getting rice, the subsidy should be given to the grazier and withheld from the cultivator. In fact such subsidies from the community at large to particular individuals or classes are always objectionable, since by their interference with normal economic laws, they produce unfortunate results. In this case the results have been the keeping of large numbers of redundant cattle and the destruction of the grazing grounds. It follows that one of the factors which produce that ridiculous animal, the Chattisgarhi bullock, is the existence of these low rates. Ideally the special rates should be abolished and a real commercial rate fixed. But we are dealing with an existing state of affairs and not constructing a Utopia, and it is unfortunately true that the sudden withdrawal of subsidy is as damaging to the economic life of the community as its grant. Withdrawal would have to be very gradual, and a time of economic stress such as this is hardly a good opportunity to start it. Therefore, only where it is absolutely necessary to avoid deterioration of the grazing and the destruction of the forests, do I propose to take away any privileges actually enjoyed at the moment, but I propose to avoid in the future such uncontrolled increase of these privileges as has occurred in the past 20 years. Where I actually propose an enlargement of the existing privileges it is because I consider that no loss and even some gain to the department will result or because there exists some reasonable grievance which can be remedied."

He goes on to say regarding the failure of previous restrictions:

* * *

"The motive of the restriction to privileged and ordinary cattle was to keep the incidence of grazing low, yet in spite of this restriction the incidence has largely increased and is now heavy enough to be causing damage to tree growth and progressive deterioration of the grazing. The grazing of cattle in excess of the fixed limits has not been prevented but the effective license fee payable for the grazing of these cattle has been increased by the amount of the bribe or the difficulty involved in the necessary fraud, without any increase of revenue to the department. This would indicate raising of the rates as the more natural and less wasteful method of restriction but the economic conditions of the present year make it necessary to be cautious in the use of such a method. The gradual enforcement of higher rates mentioned below will avoid the difficulty produced by the present 'economic blizzard' while effectively reducing the incidence before irretrievable damage is done. It will be necessary drastically to reduce the number of cattle grazing in many of the units, at the same time doing as little as possible, to deprive the cultivators, especially the poor ones, of privileges already enjoyed. It is also necessary to reduce the temptation to fraud which the exclusion of commercial cattle presents, while making such fraud, as will occur, more capable of control."

This statement of the case could hardly be bettered—in fact the whole report, particularly the solution of the practical difficulties of restriction by frequent revisions of the rates, is worthy of serious attention. It is unfortunate that the conclusions arrived at by this Revenue Officer were not given the attention they deserved nor allowed to be tested as he wished in that particular district. However, the effect of increasing grazing rates has been observed elsewhere and the conclusions arrived at by the Special Revenue Officer of Bilaspur have been confirmed by such evidence as the following taken from an inspection note of mine written during a tour of Saugor Division (1930):

"Garhakota Ramna is a compact block of forest of nearly 3,000 acres in the Saugor district, surrounded by prosperous villages and previously closed to grazing. At the 1926 grazing settlement, 300 cattle were admitted to graze over this area at low rates. The

result was wholesale illicit grazing and endless trouble to the department. The 1939 revision of the grazing settlement made provision for 1,300 cattle from nine surrounding villages and fixed a fairly heavy rate of one rupee per head of cattle. The result has been that actually 700 cattle have used the privilege, giving the ideal incidence of four acres. The cattle owners who pay this revenue are themselves anxious to keep out illicit grazing. There is also a tendency to reduce the number of uneconomic stock. In short, under this arrangement the forest is rapidly improving as the grass is kept down, Government gets a fair price for grazing without much trouble, and above all, a steady selective influence is exerted on the quality of the stock. Here is thus a practical demonstration of what a firm policy with regard to grazing rates can do."

This evidence has been used by the Silviculturist in his note on the Fodder and Grazing Position in the Province (1941) and he arrives at the same general conclusion after examining various aspects of the subject of grazing in great detail. It is intended to discuss this sort of thing fully at the C.P. Forest Policy Committee Meeting if it is held.

15. *The Problem of Trained Staff.*—Some of the large numbers of other problems not of post-war but of present importance referred to by the Inspector-General of Forests in his *Note on Post-war Policy* still await solution here and their solution needs rapid finalisation by the Committee. As regards staff alone they have become acute on account of the failure to provide a substitute for the I.F.S. and P.F.S.—to which services there was no recruitment for 14 years. The few recruits we now have, to a service still not properly defined, are not as good as they would have been had their terms of service or adequate scales of pay been clearly stated. These men will still take years to train. For war purposes we have filled the gap by promoting Rangers as temporary E.A.C. Forests with the result that good Rangers are scarce. The scales of pay of Deputy Rangers, Foresters and Forest Guards are most inadequate. Foresters selected for the Balaghat Forest School, given a year's training and let loose on the unsuspecting public are still apparently expected to be honest on a salary of Rs. 20 per month with a temporary dearness allowance of Rs. 9 per month. The protective and capital value of the property in the charge of these men—not the revenue produced (although a net surplus revenue of 75 lakhs even by that regrettable standard demands attention) should ensure at least that the subordinate staff of the Police Department and Forest Department are paid equally—as they were before Forest Policy was ignored. If, as is to be hoped, the Forest Officer is to be given more respect for what he does in the preservation of soil fertility—with all that it implies the fact should be expressed in the practical form suggested.

16. *Revenue Production as the Criterion of Efficiency.*—As regards revenue production it must be also recorded that Governments of this province have at times in the past, perhaps like most governments, departed from the sound principles of the Government of India policy, and a change of heart or, shall we say, of policy, is needed. Although "Revenue alone has never been the main aim of the Government of India"—perusal of Governments' comments in resolutions upon successive annual reports of the Forest Department would show that revenue production has tended to become the usual criterion of efficiency of the Forest Department and (with some honourable exceptions) it may be said that little interest or support has been elicited by any activities of the department which did not swell the budget or which involved immediately unprofitable expenditure. Such expressions as "The Forest Department is, after all, a semi-commercial concern" are familiar to us. A province with the largest territorial forest divisions in India should not require Post-war Reconstruction to remind it of the necessity for a Working Plan Circle nor should it have had to provide 25 per cent. of India's War Timber mainly felled, logged, transported and even sawn departmentally without even a temporary Utilization Circle. Sufficient credit does not appear to have been

given for the great value of the concessions made available to the people nor of the economic value of the 10,676 miles of motorable fair-weather roads which the Forest Department has constructed from its own funds, in opening up the country. A minimum profit of $15\frac{1}{2}$ per cent. is still demanded on any new road project. It will be seen that we have travelled far along the slippery path of revenue-hunting and the Forest Department of this province probably puts back a smaller proportion of its revenue into the forests themselves than any forest department in British India. Here, therefore, are not only grounds for setting our house in order and rectification of policy, but also fresh illustrations of what an indefinite forest policy has done. Revenue-hunting has been encouraged more by methods of gentle reproach than of anger, and it must be admitted that the revenue-hunting owner is a familiar "Danger to which the crop is liable" elsewhere than in the C. P. (though not specifically listed in Schlich, Vol. IV)! The 1894 forest policy dwelt too lightly on this matter but it must be remembered that many reserves in those days had never been opened up and the reservoir of unexploited forest was still vast. Now that the principle of the sustained yield has in theory at least been applied to all forests a more "Political" policy might perhaps be considered which would fix a definite forest revenue for say 10 years at say 10 lakhs (15 lakhs being roughly our pre-war average). If timber market conditions enabled 15 lakhs to be realised then in the following year five lakhs worth of fuel concessions could be given to the people. If, however, the timber market conditions resulted in only a five lakh surplus then fuel in the following year could be made to cost more or, alternatively, or concurrently, the opportunity might be taken to raise the concessional grazing rates. This is, of course, a simplified example of a general idea which possibly if worked out and applied might result in state forests being regarded in a more intimate sense the property and perhaps even the pride of the people. It might provide a closer link-up with the cowdung problem. Not only could fuel be made cheaper in a good year (or just after it) but some of the available surplus might be devoted to such forest activities as forest schools, aboriginal uplift, anti-malarial work and so on. The contribution to the provincial budget would be fixed for a definite period and fluctuations in the surplus over and above it compensated and related directly to forest development and rural economy. Some real development of the forest sense may be expected if the benefits derived by communities living near forests are *directly* associated with the prosperity of the forests themselves—and this can never happen if all forest revenue is automatically absorbed in the general revenues.

17. *Control of Private Forests and Creation of Fuel Reserves.*—Positive and detailed forest policy is finally required in the C. P. in respect of private forests and the provision of fuel forests in certain fuel-starved areas. There is little which need be repeated here which has not already been said in the Inspector-General of Forests' note. We have the three great plains of Berar, Nagpur and Chhattisgarh where the cowdung-burning problem exists to a varying extent. The Government of India forest policy, it may be noted, applies to state forests only. Something new is required in the matter of private forest control. Preliminary survey must be arranged for in connection with the proposed Soil Conservation Circle and legislation. The Province of Orissa has done some pioneer work in the latter direction which provides a valuable lead. The existing provisions of Sections 204/205, 211 of the C. P. Land Revenue Act do, it is true, already provide for some control by the Revenue Department of private forests, but these provisions have never been very effective in practice as no staff has been provided for the purpose of enforcing them.

18. *Conclusion.*—I have attempted to describe, as a matter of general interest, and within the limits of this somewhat discursive note which has already become much longer than I intended, the rough outlines of the

grounds which I hope will be covered by the C. P. Forest Policy Committee, if convened as I have requested. This is not intended to be a catalogue of woes nor of criticisms of Government. I have every reason to expect that the matters mentioned will be dealt with sympathetically and as fairly as such things go. The need for modernisation of the attitude of Governments in India towards forestry is now generally recognised and the need for a balanced agriculture and economy appreciated.

The Forest Department case has largely gone by default in the past and it must be frankly admitted that professional apathy and weakness have at times been evident. It is earnestly hoped that now that things appear to be on the move in a larger way in the direction of Land Use Planning, the provinces will do their best to evolve a rational and sound local Forest Policy before the October meeting of the All-India Post-war Reconstruction Policy Committee in the ways I have attempted to indicate and so help to achieve the objects set forth in the Forest Resolutions of the first meeting of that Committee recently held at Simla.

As a last word I would inflict the following quotation—if the Editor permits it—from a recent book, *Landfalls* and *Windfalls*, by W. J. Blyton (with my apologies to the Finance Department—the real masters of the situation):

"*Yes, on the whole, a curse be upon the* money criterion, first, last and all the time. It is against the slow, profound intelligence of Nature, it is rebuked by the very life cycles and aspect of beast, bird, plant and tree. She who grows the patient undemanding oak and ash and chestnut is not going to be speeded up; and all she gives she demands back in some form or other. She is a lady if so treated; and if not, a slut or a fury. She knows a lover very soon; and lovers I am afraid it must be added, are born, not made. In my part there is a saying "It may be good business, but it's bad farming." What a pregnant criticism that truth is upon the one-sided development of the past century! Because, you know, there is no evidence that creation was made for dividends; but there is evidence that it was made for crops, growth and gradualness."

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APPENDIX

Resolutions of The Policy Committee on Matters Related to Forestry

I—Whereas :

* * * *

(3) The land and water resources of the country constitute its capital wealth :

* * * *

This Committee recommends that :

* * * *

(*ix*) Suitable steps should be taken for the proper conservation and development of the land and water resources of the country.

V—Whereas :

(3) The means by which production can be increased have to be made available to producers for the purpose.

* * * *

This Committee recommends that :

* * * *

(*ii*) A Central Land Utilization Board should be set up to plan and co-ordinate work on an all-India basis in respect of soil erosion, forestry, land reclamation, irrigation works and other forms of land improvement with the necessary finance and staff.

(*iii*) A small sub-committee should be appointed to work out further details in respect of the proposed Board and asked to submit its report within three months.

* * * *

VI—Whereas :

It is necessary to ensure that the execution of works of general utility and the adoption of measures calculated to benefit the community as a whole are not held up on account of the opposition of a few individuals.

This Committee recommends that :

The Government concerned should acquire legislative powers to use compulsion in respect of such matters as :

* * * *

(*f*) The preservation of forests in catchment areas.

(*g*) The control of grazing.

(*h*) The improvement and expansion of pasture land.

VII—Whereas :

(1) The existence of an appropriate area of forest. suitably distributed, exerts a mitigating influence on extremes of climate : and whereas

(2) Over 35 per cent of the area of India is not at present under either cultivation or forest; and whereas—

(3) Forest management, especially in head-water areas, is the most effective land management as an insurance against the disastrous effects of floods and erosion and whereas—

(4) The existing forest resources of India are inadequate in extent and unsuitably distributed to supply the needs of the population, especially the village population, in fuel and small timber, and whereas—

(5) The provision of fuel is necessary to release farmyard manure for use as fertiliser; and whereas—

(6) Unregulated grazing has been responsible for much forest devastation.

The Committee recommends—

(*a*) That the reserved forests be immediately examined and working plans revised or prepared to ensure the conservative management that will be necessary for a few years to repair the damage done by advance fellings during the war;

(*b*) That the land the protection of which is necessary for the preservation of the general climatic and physical condition of the country and for the conservation of water in the catchment areas should be defined and placed under proper management, the experience and special knowledge of the Forest Department being utilised to the maximum for the purpose;

(*c*) That each Province and state should aim at having not less than 20 per cent. and if possible 25 per cent. of its area under forest and so distributed that the villager may be enabled to satisfy his requirements of agricultural timber and fuel within a reasonable distance of his home;

(*d*) That as a basis for the extension of forest areas and especially village forests and forests in areas of low rainfall, a classification should be undertaken forthwith of uncultivated land to determine the areas in which timber can be grown or forest management should be introduced;

(*e*) That soil conservation circles should be formed in each province and State to deal with land management, the regulation of grazing with due regard to the needs of the cattle population and the growing of trees whether as a protection against floods, erosion or desiccation or to supply the needs of the rural population;

(*f*) That the Central Government should appoint, as soon as possible, an erosion survey officer to investigate, in association with provincial (and state) forest, agricultural and Engineer officers detailed for the purpose in each province (and state) the problem of erosion, region by region, throughout the country;

(*g*) That for the conservation and extension of the forest resources of the country, powers should be taken by Government to exercise control of privately owned forests up to the extent of full management if necessary;

(*h*) That steps should be taken for the development of industries for the utilisation of minor forest produce which will provide avenues of employment for the growing population in forest tracts;

(*i*) That steps should be taken as early as possible to train forest staff of the necessary grades so that the personnel may be available to carry out the foregoing.

IX—B—Whereas :

(1) It is realised that it is not possible to take up development equally intensively along all lines at the same time and whereas:

(2) It is necessary to put first things first;

The Committee recommends that—

(*i*) The training of the necessary staff should be taken up as soon as possible.

(*ii*) The essential surveys of waste land and land necessary for protection against floods and erosion should be carried out as expeditiously as possible; work should not be held up till all surveys are completed but should be taken up wherever practicable as the surveys are completed;

(*iii*) The expansion and development of minor forests should be started, though any revision of management necessary in existing reserved forests will naturally be done at once.

(*iv*) If, to assess the staff to be trained under (*i*), it is necessary to set up the Provincial Forest Policy Commission, this should have first priority and be set up at once.

X—B Whereas :

(1) A properly-planned policy and programme is necessary for agricology (including fisheries) and forests.

(2) Decisions on the recommendations of the committee should be arrived at as soon as possible.

This Committee recommends that:

Provincial governments should be requested to help the Committee by communicating to it their views, criticisms and concrete suggestions in respect of the various recommendations of the Committee within a period of three months.

XII.

This Committee places on record its appreciation of the very useful and important memoranda on * * * * Forests by Sir Herbert Howard * * * * and approves in general the recommendations made in the memoranda.

THE ANDAMAN FORESTS AND THEIR REGENERATION—II*

By B. S. Chengapa, P.F.S.

(Formerly Assistant to the Chief Forest Officer, Andamans)

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CHAPTER III—REGENERATION IN GENERAL

EARLY HISTORY

The Andaman forest are no exception to the general rule in India that it is in the seral stage that a forest is economically most valuable. In order to maintain these forests in that stage, the Forest Department, that was formed in 1883, tried, from the very outset, various methods, both artificial and natural, to raise at first *padauk* and teak (an exotic) and later *gurjan,* white *dhup* and others, as these, then, lesser-known timber species began to feel their way in the world market.

Between 1883—1889, 71 acres of plantations—31 acres pure *padauk* and 40 acres *padauk* mixed with teak, were raised in Wimberlygunj after clearfelling and burning the original jungle. Plants raised in nurseries were planted at a distance of nine by four feet. In the case of mixtures, a row of teak alternated with a row of *padauk.*

In 1885, it was found (Forest administration report for 1885-86) that the 1883 plantations were growing into thin poles with only a tuft of leaves at the top and with no branches at all. It was, therefore, considered abortive.

Subsequent examination in 1914 showed that *padauk* was growing very well and was taller when grown in a mixture with teak, and thinner in girth than those grown in pure crops.

Recent examinations showed that these are some of the most successful plantations in the Andamans.

Cost of formation was Rs. 36 and upkeep up to 1914 was Rs. 57 or a total of Rs. 96 per acre (subsequent figures are not available).

Between 1886—1895, an area of 1,771 acres of *padauk* and teak—1,270 acres in Alimasjid, 188 acres in Dhanikari and 313 acres in Wimberlygunj was similarly planted, but in lines 20—40 feet wide with an intervening belt of

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* Part I of this article appeared in the **Indian Forester** of September, 1944.

jungle 80 to 200 feet wide. In the early period, teak and *padauk* alternated in the same line. But later it was found that teak was growing faster and was interfering with the development of *padauk*. They were, therefore, planted in alternate lines.

In 1903 an examination showed that the whole area had reverted to useless jungle. Some of the teak trees still found in this area are only three feet in girth and are badly shaped.

Between 1895—1903, 265 acres of mangrove plantations (*Bruguiera gymnorhiza*) were raised in Brigade creek and also in Dhaniscari creeks at a cost of Rs. 86 per acre. No other species were planted.

Records show that only 22 acres are successful. These areas are now completely stocked with mangrove with self-sown seeds after the area was abandoned.

Between 1903 and 1912, 1,323 acres of plantations were raised in Wimberlygunj valley. The method practised was that three to five *padauk* seeds were dibbled in at stakes six by six feet, except in 1906, 1907 and 1910, when ten by four feet and also twelve by three feet spacing was adopted.

Germination of *padauk* was poor; seeds were, therefore, exposed to rain for a week and then sown. This raised the percentage of germination from 15 to 60 per cent. Also temporary nurseries were opened in every plantation to fill up blanks with transplants. *Padauk* was grown pure except in 1904 and 1906 when *pyinma* (*Lagerstrœmia hypoluca*), to act as a nurse to *padauk*, was sown broadcast between the lines of *padauk*. *Pyinma* grew very much faster than *padauk* and was, therefore, considered unsuitable as a nurse. Later it was found that it did exercise decided influence in mutually shaping the boles of the young crop, though in some places *pyinma* formed pure patches, killing out or suppressing *padauk*. On the whole, *padauk* in these plantations are very much better than in other areas (*Annual Report for* 1917-18).

In 1907 hill paddy, sesamum and cottonseed, obtained from Burma, were sown. Paddy was successful and continued to be sown until it was discarded in 1912; it was found that grass invaded the area immediately after the removal of paddy and choked the seedling crop. Paddy also was becoming increasingly heavy and was found to be damaging the young plants. The yield of paddy was 235 lbs. per acre.

The area cleared and burnt for these plantations had been felled over previously for fuel. The cost of formation and upkeep was, therefore, Rs. 40 only per acre.

In 1936 an examination of these plantations showed that, except for the higher slopes that failed completely, the whole area was a fairly good success. The area now considered worth tending is 1,050 acres.

Between 1913—1921 was a period of great activity and an ambitious attempt to expand in all directions. The Great War had brought many of the lesser-known timber species in the market. Therefore, intensive efforts, both artificial and natural, to raise all species then in demand were made and these activities extended to Middle Andaman and also to North Andaman.

During this period, the question of fuel supply to the local population was causing great anxiety as it was feared that the mangrove fuel supply round about Port Blair was getting exhausted. The mangrove plantations—685 acres raised until then, were also not much of a successs; in fact many plantations had already failed. The sawmill refuse was hardly sufficient to feed the sawmill boilers. Therefore, attempts were made to introduce quick-growing exotics as a source of fuel supply.

By artificial methods 1,351 acres of plantations were raised and the species planted were:—

INDIGENOUS SPECIES—

	ACRES
Pure *padauk*	372
Pure *kanazo* (*Baccaurea sapida*)	30
Pure white *dhup* ...	$47\frac{1}{2}$
Pure white *chuglam* (*Terminalia bialata*)	12

Pure black *chuglam* (*T. manii*)	...	12
Koko (*Albizzia Lebbex*)	...	23½
Lal bombwe (*Planchonia andamanica*)	...	20
Pyinma (*Lagerstroemia hypo-leuca*)	...	7
Taungpeinne (*Artocarpus chaplasha*)	...	15
Total	...	539

EXOTICS—

		Acres
Pure teak	...	12½
Eucalyptus	...	5½
Albizzia moluccana	...	64
Total	...	82

MIXTURES—

Teak and *padauk*	...	200
Teak, *padauk* and *koko*	...	45
Teak, *padauk* and *pyinma*	...	88
Teak and *Casuarina*	...	55
Albizzia and eucalyptus	...	122
Albizzia and *padauk*	...	160
Afzelia palambanica and mahogany	...	8
Total	...	678
MISCELLANEOUS SPECIES	...	52
Total	...	730

The method practised was very much the same as in the previous periods. The vegetation, mostly after extraction for fuel, was cut and burnt and the seeds were dibbled or were sown broadcast. The cost of raising these plantations varied from 25 to 40 per acre for creation.

Seventeen species of eucalpytus obtained from Australia were tried. Seeds were sown in a nursery and the seedlings from nurseries were pricked out. The majority of them died out and the species that showed any sign of success were *Eucalyptus tereticornis, resinifera, robusta, rostrata* and *botryoides*.

Eucalyptus plantations are now a complete failure except for a few trees in private gardens.

Albizzia moluccana seeds were obtained from Ceylon. They grew very fast and reached 40—50 feet high in three years. *Casuarina* failed to germinate.

An examination of these plantations in 1934 showed that, out of 1,351 acres originally planted, only 448 acres were found worth tending. *Koko, Lal-Bombwe* and *Taungpeing* had failed completely. Mixtures of *padauk*, teak, *koko* and *pyinma* are about the best plantations of this period.

According to records available, natural methods were first attempted in 1911. During this year, and also in 1912, in order to induce regeneration and to obtain its development, cultural operations, *e.g.*, freeing the seedlings and saplings in gaps and clearing round *padauk* seed-bearers, were carried out in Rutland and Baratong islands. But, like the fellings, these gaps and clearings were scattered, and like all such work, were lost sight of and forgotten. It is now impossible to trace a single gap and any such gaps are now but a tangled mass of useless evergreen shrubs and weeds. In 1915, therefore, Bonington laid down in his working plan for the Andamans that cultural operations to aid natural regeneration should be confined to definite areas. He proposed that lines 50 feet wide should be cleared at suitable intervals in *padauk* forests; teak and *padauk* should be sown in these lines and the necessary cleanings carried out until the young crop was established. This procedure was found by experience to be impracticable. (*Forest Administration report, 1926-27, para. 5.*)

In 1914 an area of 10 acres in *padauk* forests at Ohenleade in the Middle Andaman was selected and undergrowth removed varying from complete to partial clearing. The refuse was stacked in heaps and *padauk* seeds were sown broadcast over the whole area. No subsequent weeding or cleaning was done. After two years, only a dense growth of weeds and climbers 10 feet high was found with about a dozen young *padauk* struggling through.

(Forest Administration report for 1916-17, para. 33.)

In 1914—16 an area of 50 acres was demarcated in Bomiungla and improvement fellings, including cutting climbers over *padauk* trees, were carried out, creating numerous little gaps in the canopy. *Padauk* seedlings soon filled up these little gaps and were kept thoroughly weeded for two years, but the overhead cover closed in again and killed the young crop. The whole area was, therefore, artificially regenerated.

In 1910 a small area with a large number of *gurjan* (*Dipterocarpus* spp.) seedlings, a year old, was noticed in Wimberlygunj fuel working area. All overhead shade was at once removed and the area was thoroughly weeded for two years. It was hoped that this would be a great success, but later it appears to have been forgotten, and at present no trace of *gurjan* is to be found. No further attempt at natural regeneration is thereafter recorded.

It was, however, found that natural regeneration was extremely difficult and unsatisfactory. Therefore, after 1916, all experiments on natural regeneration were abandoned and experiments with clear-felling and planting were continued until, in 1921, the conclusion arrived at was: "Artificial reproduction is so easy and is so much more reliable than natural reproduction that the latter is not of such vital importance as the former. In such cleared places the growth of weeds and more particularly of creepers is exceedingly profuse and this is a strong reason for resorting to artificial means." (*Forest Annual Administration Report for 1921, para. 30,* and summary of progress during 1914-15 to 1918-19, para. 13.) "Artificial reproduction, therefore, became the rule and natural reproduction became one of interest mainly in guiding artificial efforts." (*Forest Annual Administration for 1922.)*

Accordingly, plantation methods were continued with great vigour until 1933, though the maximum area that could be planted in any one year was rarely more than 100 acres and this was considered a great achievement.

From 1921—26 was a period of inactivity perhaps because of a natural reaction to the failure to successfully regenerate the forests whether by natural means or by artificial methods. *Taungya,* as practised in Burma, was contemplated and a large number of men were imported for this work. These men tried some hill paddy in Rangat and found that this was being affected by a disease called "blight." However, after a short time in the Andamans, they went back to Burma, returned with their families and settled down in North Andaman but did not undertake any *taungya* work. The staff was busy with the construction of tramlines and the unfortunate North Andaman mill and trying to make a success of the newly-opened North Andaman Division. Scientific Forestry was competely forgotten and the Department virtually degenerated into a big lumbering camp.

From 1927—1933 a new lease of life was again given to artificial methods and 530 acres of plantations were raised, 188 acres in North Andaman (Sound Island) or an average in North Andaman (Sound Island) or an average of 66 acres a year at a cost varying from Rs. 45 to Rs. 200 per acre for creation alone.

The method practised varied very much from the previous methods. Seeds of *padauk* and teak were first treated (parboiled or exposed to sun and rain for three days) and then sown in temporary nurseries. As soon as they showed signs of germination, the germinating seeds were picked up and dibbled at stakes six by six feet in Long Island and six by three feet in Sound Island. Later on, in Sound Island, this practice was discontinued and *padauk* plants obtained from the adjoining jungle were planted out at stakes six by four feet. Between the lines, maize and sugarcane were planted. The revenue realised was credited towards the account of these plantations. However, it was soon found that sugarcane and maize could not be sold; the field-crop was, therefore, discontinued.

Teak, *padauk, pyinma,* white *chuglam,* white *dhup, koko, gurjan* and *ywegi* (*Adenanthera pavonina*) were tried. Pure *koko* was killed by pigs and a leaf and shoot defoliator, *gurjan* died out completely in hot weather, white

dhup refused to germinate in Long Island; others came up fairly well.

Out of 530 acres of plantations thus raised only 256 acres are now considered worth tending.

During this period of 50 years from 1883 to 1933 a total of 5,046 acres of *padauk* and other plantations were raised, at costs varying from 45 to 200 per acre for creation alone. Until 1926 the areas clearfelled for supply of fuel to the settlement were taken up for planting purposes. The cost of forming these plantations was, therefore, rarely more than Rs. 60 per acre. Cheap convict labour was then available. After 1926, however, it became necessary to clear-fell high forests and to debit the cost of felling to the plantations. Sugarcane and maize were introduced as field crops to keep down weeds and to foster the healthy development of *padauk* seedlings. *Padauk,* white *dhup, koko,* white *chuglam* and *Lal bombway* were planted. *Gurjan,* white *dhup, koko* and *Lal bombway* failed. Sugarcane and maize, for want of purchasers, were issued to elephants, but no corresponding decrease in their usual grain ration could be made. The cost of plantations for the first year's operation varied, in some cases, from Rs. 100 to Rs. 200 per acre, and a careful examination of the plantations revealed that, out of 5,046 acres of plantations thus raised (this excludes 885 acres of mangrove plantations), only 1,825 acres—including what some officers called "Success with a stretch of imagination"—are now considered worth tending. This is only 33 per cent. of the original area planted and the cost of formation is, therefore, trebled, making plantations financially thoroughly unsound.

The annual extraction of timber was about 30,000 tons, obtained by selection fellings, aptly termed by Sir Lawrence Mason, "picking-the-plum system." The area traversed in the course of this felling was roughly about 4,000 acres, and the area planted was about 70 acres, of which only 35 acres could be counted as a future success. This was, therefore, nothing but lumbering, undisguised by any attempt to work on a sustained-yield basis or to obtain normal regeneration. This was, indeed, very distressing to a trained professional forester. But there was no way out of it and the situation, though very bad indeed, was accepted as unavoidable.

CAUSES FOR THE FAILURE OF NATURAL REGENERATION IN THE PAST

A careful study of the past attempts to raise natural regeneration shows that they centred round gaps, patches and strips, created by special fellings. *Padauk* and its associates do not grow well along the edges of plantations and regeneration areas with a surround of high forest and, therefore, cannot be expected to do well in small gaps, patches or strips. Large gaps with increased light stimulate weed growth to exuberance in these islands and make cleanings very costly. Therefore, all attempts to raise natural regeneration were abandoned after 1921 in favour of clearfelling and planting.

In 1929 and 1930, the carrying out of the mapping and enumeration in the Middle Andaman afforded the author a rare opportunity of going over about 10,000 acres thoroughly and also seeing the greater part of the forests of other islands, and afforded facilities for the study of the different types of vegetation and their present condition. What was noticed as strange then, was the preponderance of mature and overmature timber trees, a totally inadequate representation of the younger-age classes, and an almost complete absence of seedlings and saplings, even though these were found in abundance in tramway cuttings, roadsides, abandoned camp-sites and also in recently-felled areas. The gaps of the past fellings were an impenetrable mass of climbers and useless evergreen shrubs. The reason for this state of affairs appeared to be that almost all the trees in the upper storey are deciduous; everything below this is evergreen. A careful perusal of the description of the forests will show that this is so. The more light-demanding deciduous and semi-deciduous species, therefore, have small chance of pushing their way through

the dense evergreen under-storey; in many cases their fruits or seeds (mostly winged) never reach the mineral soil at all. The evergreen undergrowth and the evergreen under-storey thus hinder germination and obstruct development beyond the seedling stage. The removal of these hindrances, therefore, appeared imperative for the successful regeneration of *padauk* and other desirable species, a fact that was overlooked in the past attempts to raise natural regeneration.

CHAPTER IV—REGENERATION OF MOIST DECIDUOUS AND RIVERAIN FORESTS

RECENT ATTEMPTS

The regeneration problem in the Andamans is twofold: (1) The regeneration of areas fairly heavily-felled over 10 or 15 years ago and now covered with a dense growth of climbers and evergreen shrubs, and (2) The regeneration of areas felled over recently when regeneration operations follow extraction closely. In such areas numerous gaps are found with or without seedlings on the ground, undergrowth is scanty, having been thinned out during felling and dragging, and the soil is sometimes disturbed by the falling trees and also by dragging timber. Experiments in an area of the first type at Porlob Island, and in areas of the second type at Bajalungta and later Interview Island, were started in 1931.

First Laltikri experiment—Porlob Island—14 acres.

This island, at the time of the experiment, was covered with deciduous and semi-deciduous forests with occasional patches of evergreen. It was first felled over 15 years previously for *padauk, pyinma* and also to a small extent *gurjan.* What remained was seven or eight unsound or immature trees of useful species per acre (*Gurjan* and *padauk* below nine feet in girth, white *chuglam* eight feet, white *dhup* and *papita* below six feet and others below seven feet were considered immature). These, with other less valuable species, formed a close canopy with very few interruptions; the underwood was evergreen, thick and impenetrable, with masses of climbers and canes.

In November, 1930, an area of 14 acres was demarcated, and in November and December all undergrowth was cleared and the under-storey up to a height of 60 feet from the ground was felled, except in places where the uniformity of the overhead cover had been interrupted as a result of the past fellings. Uniform overhead cover was, as far as possible, maintained. The object of this cover was to check the exuberance of weed growth and to maintain the original character of the vegetation in case of failure to raise a seedling crop. The refuse on the ground was too thick to allow the seeds of *padauk* and its associates to reach the mineral soil. This was, therefore, burnt at the end of March. It is impossible to secure a thorough burn in these islands where rainfall occurs almost every month. Heaping and burning was, therefore, done in April. At the end of April, *padauk* and white *chuglam* seeds began to fall from the mother trees and, by the end of May, the ground was well covered with self-sown seeds. With the rains in May the seeds began to germinate and before the end of June the whole area was one sea of seedlings, hardly a square foot of space being without some useful seedling or other.

About the middle of July weeds, especially *Trema, Ipomea* and *Thunbergia,* began to appear, but weed growth was feeble compared with that found in plantations. The area was weeded in July, and again in October, 1931. In October a representative area was counted and about 12,000 seedlings per acre were found—50 per cent. white *chuglam,* 30 per cent. *padauk* and 20 per cent. white *dhup, pyinma* and others. The average height was then about three inches. In October, 1931, the canopy was completely removed by girdling all the remaining trees. The sudden removal of the overhead cover induced a rank growth of weeds and climbers and the subsequent weedings became costly, though still comparing favourably with those in a plantation. In July, 1932, the area was weeded, and again weeded and

cleaned in October. In cleaning, all white *chuglam* interfering with *padauk* were cut; the total number of seedlings after this cleaning was 10,000 per acre. White *dhup* now appeared to preponderate because of its faster growth and larger leaves, though the proportion remained still the same. The best *padauk* had reached seven feet in height, and the best white *chuglam* and white *dhup* 10 feet in height. In June and July, 1933, a heavy cleaning was made over the whole area, aiming at 50 per cent. *padauk* and 50 per cent. other species. A count still showed some 6,000 plants per acre, the mixture being mostly in small groups; weeds had disappeared but climbers were still a source of great anxiety. *Padauk* had reached an average height of 10 feet and white *dhup, pyinma* and white *chuglam* 15 feet. The total cost up to 31st March, 1933, was Rs. 42-13-0 per acre.

The excellent result obtained in this experiment led to its repetition on a larger scale to determine the best shade conditions necessary to secure regeneration and their subsequent development; keeping down, at the same time, the excessive weed growth.

Second Laltikri experiment—Porlob Island. In November, 1931, an area of 74 acres adjoining the previous experiment was demarcated and divided into five plots in which the overhead cover was removed to different degrees in November and December, 1931.

EXPERIMENT I.—5 ACRES

The undergrowth up to a height of 10 feet from the ground was cut and burnt in April, 1932. With the rains in June seedlings in great numbers resulted from self-sown seeds. In August and September they died out completely. The cost was Rs. 5 per acre.

EXPERIMENT II.—7½ ACRES

The overhead cover was raised to 20 feet and seedlings appeared in abundance. They lingered on till October and started dying out in November, 1932. The canopy was then raised to 60 feet by felling and girdling trees in the under-storey. The plants were sickly and only a foot high and made little or no progress. In the hot weather, April and May, 1933, about 50 per cent. died, but with the rains in June and July, the surviving plants revived and reached an average height of 2½ feet in October, 1933. This area was free from weeds in the first year and the cost was Rs. 10-8-0 per acre to the end of March, 1933.

EXPERIMENT III.—14 ACRES

The undergrowth and the tree-growth up to a height of 40 feet from the ground were cut in November and December and burnt in April, 1932. Seedlings came up in large numbers in June and July and started dying in October. The tree cover was, therefore, raised to 60 feet. The seedlings were then only 1½ to 2 feet high and made little or no progress until the rains, though only about 25 per cent. died out. They were about three feet high in 1933. Weed growth was poor and the cost was Rs. 12-1-0 per acre to the end of March, 1933.

EXPERIMENT IV.—37 ACRES

The undergrowth and the tree growth up to a height of 60 feet from the ground level were cut in November and burnt in April, 1932. Seedlings came up in large numbers in June and July, and before the end of October reached an average height of 2½ feet. Weed growth was slow in the beginning; the first weeding was carried out in August and the second in October, 1932. In November it was noticed that the seedling crop was not making satisfactory progress. The tree cover was, therefore, raised to 80 feet from ground level. The cost of formation up to the end of March, 1933, was Rs. 25-6-0 per acre.

EXPERIMENT V.—10½ ACRES

All undergrowth and tree cover up to a height of 80 feet were cut and burnt in April, 1932. Seedlings in like numbers came up early in June and July and occupied almost every inch of space on the ground. Weeds came in early and grew rapidly, and weedings were necessary three times in 1932, in May, August and October. At the end of October the average height of the young crop was three feet. The cost of formation was Rs. 35-7-0 per acre to the end of March, 1933.

BAJALUNGTA EXPERIMENTS IN MIDDLE ANDAMAN ISLANDS

FIRST EXPERIMENT—17 ACRES

This area was covered with moist deciduous forests on undulating and raised ground, and with southern tropical semi-evergreen, or the low-level evergreen forests, along the banks of larger streams and the inner extensions of tidal flats. In 1929 and 1930 the department, and also a petty contractor with elephants and buffaloes, carried out heavy extraction of *padauk,* white *chuglam,* black *chuglam, dhup, papita, gurjan, taungpeing* and other marketable species, removing about 14 or 15 tons of timber per acre. There were still seven or eight unsound *padauk,* and also other unsound and immature useful trees per acre to act as mother trees. The undergrowth and the understorey had been disturbed to a considerable extent by the falling trees and also in making dragging paths and dragging logs. Wherever gaps had been made, a large number of seedlings of *padauk* and white *chuglam,* particularly the latter, were seen struggling through the weeds and climbers. Elsewhere regeneration was scanty.

In August, 1931, an area of 17 acres was demarcated, all undergrowth cut and the canopy raised to 60 feet and uniform overhead shade was obtained. No burning was done as the refuse on the ground was not thick enough to prevent the seeds from reaching the soil, and also for fear of the existing regeneration being burnt. In October it was noticed that the whole area was covered with seedlings of useful species 5—6,000 per acre. The advance growth had reached five feet in height, particularly in the areas where heavy opening had been made. The tree cover was, therefore, raised to about 100 feet. In May, 1932, it was thought that the canopy had been opened too soon and too suddenly. Masses of weeds and climbers came in and increased the cost of subsequent weedings. The area was weeded in May and again in September, 1932. The cost to the end of March, 1933, was Rs. 27-9-0 per acre.

In June, 1933, a cleaning was carried out aiming at 50 per cent. *padauk* and 50 per cent. other species, and climbers were cut at the same time. In November, 1933, the overhead cover was completely removed by girdling and a cleaning was again carried out. White *dhup* and white *chuglam* appeared to be predominant by reason of their fast growth and bigger leaves.

The most encouraging results obtained in this experiment at little more than half the cost of the Laltikri experiments led to its repetition on a larger scale and to a closer study of the light requirements of the species. The seedlings in this area were about a foot smaller than those of the same age at Laltikri but were equally healthy.

SECOND EXPERIMENT—68 ACRES

Early in January, 1931, a petty contractor with elephants and buffaloes concentrated his extraction of *padauk* and other marketable species, including *gurjan,* on about 300 acres which included a large proportion of drained alluvium adjoining the former area. He worked there more than a year, taking out about 20 tons of timber per acre, consequently the felling had been much heavier than is usual. Some 15—20 gaps per acre had been created and these were 60 to 70 feet in diameter. There were still seven to eight unsound or immature trees of useful species per acre on the area to provide the necessary seeds. A large number of seedlings had come up and were six inches high in the gaps, and many more were in the process of germination.

A portion of this area, 68 acres in extent, was demarcated, and in October, 1931, immediately after the completion of the extraction, undergrowth and the understorey, up to a height of 20 feet, were cut. There was no need for burning. In June and July, 1932, the area was weeded, and in September, 1932, the canopy was raised to 40 feet. In October the area was again weeded and a stock taken; 8,000 seedlings per acre were found—50 per cent. *padauk,* 25 per cent. white *dhup;* 10 per cent. *papita,* 15 per cent. white *chuglam, gurjan* on the drained alluvium and other species

well mixed up mostly in little groups. The average height was five feet. The cost up to 31st March, 1933, was Rs. 11-11-0 per acre.

In February, 1933, the canopy was raised to 60 feet, and again to 80 feet in November. The area was weeded twice, once in June and again in November. The number and proportion of the seedlings were still the same, about 8,000 per acre, though white *dhup* and *papita* appeared to predominate. The plants reached eight feet high and were completely out of danger from weeds. Climbers, however, continued to be a source of great annoyance.

INTERVIEW ISLAND EXPERIMENT—NORTH ANDAMAN

In 1930, a skidder was erected on Interview Island and extraction of timber was commenced in November of the same year. From the skidder, nine cleared lines of an average length of 30 chains and a width of 15 feet radiated in all directions, covering a circle of about 160 acres in extent. These nine lines were cleared of all vegetation for running the skidder lines. Between the lines, all logs were hauled by elephants to the cleared lines, and thence by the skidder to the logging railway. About 16 tons of timber per acre of *padauk*, *koko*, *gurjan* and other species were extracted. Apart from the cleared lines, the whole area appeared very similar to that extracted purely by the elephants in other parts of these islands. The soil in the lines was well disturbed by the logs being dragged over them with only their noses lifted.

With the rains, a large number of seedlings of white *dhup*, white *chuglam*, *pyinma*, *koko* and *padauk* came up—naturally from self-sown seeds. In October they were found varying in height from a few inches to four feet, the best plants being generally confined to the cleared lines. About 6,000 seedlings an acre were found—white *dhup* 40 per cent., white *chuglam* 30 per cent., *koko*, *padauk* and others 10 per cent. Blanks were rare. The area was weeded and the canopy raised to 60 feet in October and November, 1931. The young crop responded very well to this treatment; some of the plants had reached 15 to 20 feet in height and the cost up to the end of March 1933 was Rs. 14-4-0 per acre.

CONCLUSIONS DRAWN FROM THESE EXPERIMENTS

From the results so far obtained, it was conclusive that, in deciduous and semi-deciduous forests and also in riverain forests (low-level evergreen forests of these islands), natural regeneration of *padauk*, white *dhup*, white *chuglam*, *gurjan*, *koko* and others—some of which were very refractory and refused to respond to artificial methods—could be induced, and the best results could be obtained at a cost much below that of artificial regeneration by removing the undergrowth completely, raising the canopy to 60 feet, burning the slash if necessary and weeding constantly. Equally good results were obtained at still further reduced costs by following extraction closely and modifying the treatment slightly. Indeed these experiments definitely showed that the conclusions arrived at in 1921 in respect of artificial reproduction that "it is so easy and is so much more reliable" could now be applied to natural regeneration with greater force, and with the further addition that we are now able to "raise any species at will" and at much cheaper cost with amazingly good results everywhere.

CHAPTER V. — STANDARDIZATION OF REGENERATION FELLINGS IN SEMI-DECIDUOUS AND RIVERAIN FORESTS

From the experiments conducted so far, it was conclusive that there was no difficulty whatever in obtaining germination and securing the development of the young crop. But no finality could be reached, and nothing could be standardized except that it was found that final fellings could be completed, within three years of the initial fellings and that the cost of weeding rested almost entirely on the initial and the intermediate cuttings. Therefore, experiments mainly to reduce costs were continued.

EXPERIMENTS TO REDUCE COSTS
PORLOB AND BAJALUNGTA STRIP EXPERIMENTS

It is reckoned that the final crop in these forests should contain about 50 mature trees per acre. This is roughly 30 feet apart. There is practically no sale for poles and saplings obtained in thinning, and any expenditure incurred on thinning and also any expenditure incurred on raising the surplus seedlings to the thinning stage, *i.e.*, weeding and cleaning, are unremunerative. The aim, therefore, was to reduce this expenditure to the minimum consistent with a healthy development of the future crop. In order to secure this object, experiments to raise regeneration in strips, under the same system that proved so successful in regenerating areas wholesale, were started in 1933.

FIRST PORLOB STRIP EXPERIMENTS

Early in December, 1932, an area of 21 acres adjoining the 1933 Porlob (a wholesale regeneration area) was demarcated. This was divided into three plots of seven acres each. In the first plot strips 20 feet wide, in the 2nd strips 30 feet wide and in the 3rd strips 40 feet wide, and in every case 30 feet apart, were cleaned. These strips were given the same treatment and at the same time as that given to the 1933 wholesale area, *i.e.*, the undergrowth was completely cut and the canopy was raised to 60 feet and the brushwood was burnt wherever necessary. The intervening strip of 30 feet was left intact. The result of this was that, even in the case of 40-foot wide strips, only four-sevenths of the area was actually worked, thus saving the cost of weeding and tending over the rest of the area.

Early in the rains, seedlings of useful species came up in large numbers. These were weeded and tended according to the requirements of the crop. The cost of formation at the end of the year (i.e., 1933) was Rs. 5-13-0 as against Rs. 15-7-0 per acre in the wholesale system. But the development of the seedlings was very poor. It was, therefore, not considered worthwhile repeating the experiment in 1934 but observations on this experiment were, however, continued.

SECOND PORLOB AND BAJALUNGTA STRIP EXPERIMENTS

At the end of 1934, it was found that the young crop in the 40-foot strips was comparable with the young crop the wholesale area and the cost of weeding and tending was only Rs. 12-13-0 as against 32-7-0 per acre in the wholesale area. This experiment was, therefore, repeated in 1935, 1936 and 1937 on a larger scale in Porlob and also in Bajalungta, except that only 40-foot strips were tried.

This system of regeneration was found definitely to cheapen the cost of initial work of regeneration but it could not be said that ultimately it would be any cheaper than the wholesale system. It envisaged absolutely no work being done in the intermediate strips. The strips were, therefore, left choked with climbers and were fast spreading to the cleared strips. Also, owing to side-shade, development of the young crop was much slower. Another disadvantage of the strip system was that it was practically impossible to lay out the strips in broken country without tremendous trouble by a gazetted officer, time that could not be spared.

Also, the quick and spectacular results obtained in further experiments on the manipulation of overhead canopy completely eclipsed the strip system. In consequence, this was abandoned as most of the country to be regenerated after 1938 was pretty broken. It may, therefore, be said that this experiment has not been given a fair enough trial to draw any definite conclusion.

EXPERIMENTS TO DETERMINE THE INTENSITY OF INITIAL AND INTERMEDIATE FELLINGS

By now, it had become common knowledge that the more rigorously the canopy was removed, the faster the seedlings grew, but drastic opening stimulated weed growth to exuberance and increased cost of weeding. Mr. Foster, in his tour note, dated September, 1935, observed: "There is very consid-

erable scope for further experiment with a view to reducing costs. It might, for instance, be found in some localities that, by rapid opening up, the regeneration might get beyond reach of weeds in two years and the extra cost of weeding in the first year would be offset by avoiding weeding in the third year."

Further experiments on this line were continued and in 1937 the overhead canopy was removed in only two fellings, including the initial fellings. The initial felling usually made in December—February consisted in the removal of everything except the seed trees. The final fellings, *i.e.,* the complete removal of overhead shade, was made immediately after the first weeding. This resulted in a rapid and uniform development of the young crop, many of them reaching five or six feet high in one season or sapling stage in two seasons. The regeneration thus did get beyond the reach of weeds in two seasons and the extra cost of weeding in the first year was well offset by avoiding weeding in the third year.

Another feature of the rapid regeneration fellings is that the resulting crop has a very large percentage of *padauk,* and also that *padauk* takes the lead from the very start. In the previous slow method, white *chuglam* formed the predominant species and the percentage of *padauk* was very small (about 20 or 30 per cent.) and its growth also appeared slow in the beginning. Yet, in all the older regeneration areas a sufficient number of *padauk* (about 500 plants per acre) have worked their way through and are, in many cases, dominant with clean although thin boles.

EXPERIMENT IN KYITONG TO DETERMINE THE EXTENT OF BURNING NEEDED

When plantations were raised, it was a regular feature of the operations that high forests were felled to the ground and the brushwood was burnt. One firing was rarely enough and, therefore, trees, branches and twigs were cut into short lengths, heaped and burnt over and over again until only ash was left on the ground. This was necessary to put in stakes for sowing or planting at regular intervals and in straight lines. Some of this work was carried into natural regeneration operations also in its earlier stages and the cost of this item was about Rs. 6 or Rs. 7 per acre. Observations in various regeneration areas showed that this work was not absolutely essential, or at least to the same extent as was being carried out. To determine whether it was absolutely essential to burn the slash to obtain regeneration, an area of five acres was opened in Kyitong in 1936. In this area undergrowth up to a height of 20 feet was cut down and everything else except mother trees was girdled. In this way, unnecessary collection of brushwood and consequently burning was avoided. At the end of May it was found that the area was fully stocked with small seedlings. Their subsequent development was not very much inferior to the crop in other areas. This, and also observations in other regeneration areas, showed that, provided that brushwood is not too thick on the floor, regeneration can be induced and their subsequent development secured, without burning the slash on the ground. Therefore, cutting into billets and heaping was stopped, and burning was restricted to a general fire over the whole area and particularly to thick brushwood, which would interfere with the free development of the future crop. This enabled reduction of cost to about Rs. 2 per acre for this item of work against Rs. 4 to Rs. 6 previously.

CONCLUSIONS AND STANDARDIZATION OF REGENERATION FELLINGS

From 14 acres of experimental regeneration area in Porlob in 1931, it steadily rose to 1,666 acres in 1941 and the total area regenerated during this experimental period of 10 years was 8,920 acres. This is virtually five times the area raised by plantation methods in 50 years. The cost of formation was gradually brought down from Rs. 48-1-0 to Rs. 20, and in some cases to even Rs. 15 per acre. This is only a fraction of what was being spent on raising plantations. The results were amazingly good everywhere. It can,

therefore, be taken as conclusive that there is very little to improve on the main technique now evolved for regenerating the Andaman Forests. The method of fellings gradually crystallised itself into the following rules as a rough guide to the marking officer.

METHOD OF EXECUTING FELLINGS: INITIAL FELLINGS

1. The exploitation fellings are really the initial fellings in a regeneration block. Therefore, there is no girth-limit and everything that is saleable should be felled and removed before the end of December, leaving 15—20 seed trees, capable of producing sufficient fertile seeds, and also well distributed about 50 to 60 feet apart.

2. *Padauk* and *dhup* seeds lie dormant for over a year and the early germination, which is very desirable in the case of *padauk,* is mostly from the seeds of the previous year. Mother trees of these species are, therefore, not absolutely essential. Also, many hollow *padauk* trees are nearly always available as mother trees. However, it is desirable that at least four or five *padauk* trees (not necessarily sound) should be retained.

3. Reproduction of *chooi* (*Sagaræa elliptica*) and Marblewood (*Diospyros marmorata*) could not be obtained in the past as these trees were felled in course of initial fellings before they had seeded—*chooi* seeds in August and marblewood in October-November. Mother-trees of these species should, therefore, be left standing for more than 12 months; this secures their regeneration.

4. All climbers on seed trees should be cut while marking for felling.

5. Any timber available in the area for sale should be extracted before the end of November of the year in which it is due for regeneration fellings. The exploitation fellings should not be taken up unless the area can be immediately regenerated.

6. Immediately after the extraction of timber is over, regeneration fellings should be taken up.

7. In the initial operation, all undergrowth and trees up to a height of 30 feet not needed for seed purposes should be felled.

8. Trees above 30 feet, and not needed for seed purposes, may be girdled or felled if required to press to the ground, any thick brushwood. This ensures a good burn. It has been found that indiscriminate felling makes it necessary to carry out subsequent heaping and burning at a cost of Rs. 4 or Rs. 5 per acre. This also raises the cost of weeding as the coolies have to hack their way through every time they weed the area. Felling should, therefore, be discouraged. Girdling is also cheaper by Re. 1 per acre. The dead trees appear to do an exceedingly small amount of damage as they usually fall in small bits.

9. A general burning is beneficial, but no heaping and burning is necessary except where the collection of brushwood is thick. The experiments in Kyitong have shown that the young crop grows up equally well whether the brushwood is burnt or not. The 1932 and 1933 Bajalungta areas were raised without the aid of any fire.

10. In riverain forests (low-level evergreen forest), *gurjan* seedlings (*Dipterocarpus alatus*) sufficient to stock the area are always found and it is on this type of soil that the brushwood is the heaviest. It is, therefore, necessary specially to search for these seedlings, clear all round and then burn the brushwood, only if *absolutely essential.*

11. All climbers on mother trees should be cut while clearing undergrowth.

12. Burning, if necessary, should be carried out in the beginning of March.

13. Sowing is usually unnecessary, but if there is any lack of seed-bearers, seeds of such species should be collected and sown broadcast in such areas; *Papita* seeds early in March and is easily burnt after this period. Collection of *papita* (*Sterculia campanulata*) seed then becomes necessary for sowing.

FINAL FELLINGS AND TENDING THE YOUNG CROP—FIRST YEAR

In June, the young crop appears. It should be weeded in July or August. In the first weeding, it is advisable that all weeds, especially the seedlings of climbers, should be uprooted. The young crop stands an amazing amount of competition from erect weeds. This competition is beneficial to the young crop, especially to *padauk*. Therefore, no further weeding is necessary. However, climbers and other fast-growing weeds should be watched and uprooted or cut in December and January.

As the first weeding proceeds, or immediately after the first weeding, final felling should be carried out. Only saleable trees should be felled and the rest girdled. The logs should be dragged out of the area without any delay.

TENDING THE YOUNG CROP—SECOND YEAR

The young crop is at least four or five feet high in the second year and is out of reach of weeds. However, cleaning and climber-cutting are necessary in August and September. Any species, or any mixture most desired, should also be encouraged in this operation by eliminating species not desired provided that no gaps, or blanks, however small, are created by such eliminations. Blanks are *usually rare, but in such blanks, whether big* or small, no growth, however useless, except climbers, should be cut. Cutting miscellaneous growth in blanks encourages climbers and these soon spread to the adjoining areas. As the cleaning proceeds, or even earlier, any tree girdled, but not yet dead, should be regirdled or felled.

TENDING THE YOUNG CROP—THIRD YEAR

Climbers, and also any useless species directly over or interfering with the valuable species, should be cut in September-October or according to the needs of the young crop.

TENDING THE YOUNG CROP—FOURTH YEAR

Climber-cutting and cutting back any useless species directly over or interfering with the valuable species should be carried out according to the requirements of the young crop.

(*To be continued.*)

EXTRACTS

FOREST SERVICES AND THE EMPIRE FORESTRY ASSOCIATION

BY E. A. GARLAND

Any controversy on the varying merits of the lines upon which different Forest Services have developed is, in my view, fallacious and unnecessary. Unnecessary because a closer examination will show more similarities than differences; fallacious, because it looks more to the past than to the future. The thesis that Colonial forestry should be freed from the leading strings of Indian Forest Service traditions ignores the fact that very soon now, according to the present political plan, the Indian Forest Service will cease to exist, and in its place there will be a large number of quite separate Provincial and States Services. It is also based on generalizations about the I. F. S. tradition, which, whatever they may have been about twenty years or so ago, are definitely not true today. There may have been quite possibly still parts of India, just before the present war, where the forest officer's chief problem was supply, but this seems unlikely from the fact that almost all provinces had found it desirable, and incidentally perhaps profitable, to employ special Utilization Officers. In some parts of India, to my personal knowledge, almost everything which has been specified as a peculiarity of West Africa could equally well be used in a description of Indian conditions. In some parts of India there is no hunger for forest produce, and the possibilities of "rationalizing" so-called "shifting" cultivation, by regulating the periods under bush or grass fallows, have actually been prescribed for trial in at least one working plan, and will probably become an increasingly important part of forest management in several parts of India. In this connection it may be remarked that the raising of tree crops with field crops (called *taungya* and various other names, including even the monstrous "agri-cum-silviculture") is really nothing more or less than a high degree in "rationalization" of shifting cultivation. The fact has also apparently been overlooked that forestry in India started precisely in the way which has been described as an "embarrassing factor" in Nigeria. It is a historical fact that the principal impetus, which started the British interest in the forests of India was the need for teak for warships to replace the diminishing supplies of English oak. The early history of the forests of the western coastal zone in India was entirely one of "almost unrestricted creaming of the forests by European firms for a narrow range of export timbers"; in this case teak, blackwood, and *poon*. Possibly eighteen or twenty years ago it was true that some forestry experts would have had difficulty in understanding that the problem of conservation of forests and natural resources generally is quite as much a political as a service one. To-day in India we are fully awake to this fact, if for no other reason than that we have all of us had some very direct practical experiences of its truth. The Indian probably even more than the African is "not satisfied with being told that he must do things because they are good for him, and in the case of forestry he is far from convinced." Our trouble in India is generally much more concerned with convincing our governments that money would be well spent in demonstration and publicity for forestry. It seems that in Nigerian forestry experience there would be thorough agreement with the need for "recognition of the immense importance, in the economic life of the country, protective as well as in meeting the everyday needs of the mass of the population, of the fuel and grazing forests in the tracts of low rainfall." The quotation is from the review of the Annual Report on Forest Administration in the Madras Presidency for the year 1939-40, in the same issue of the *Empire Forestry Journal* in which the letter from Mr. Oliphant is published, stating the present position of forestry and the Forest Service in West Africa, as he sees it. Perhaps his views might have been somewhat different had he had a recent opportunity to see the Indian Forest Service actually at work

in India; say, perhaps, as a delegate to, the Empire Forestry Conference planned to have been held in India in 1940. At least, perhaps, they might have been stated differently. Much of his present outlook seems to be the result of making direct comparisons between the I.F.S. of twenty years ago and problems of to-day as he knows them in Nigeria, which in fact do not apparently differ greatly from the current conditions in India. That is to say, that there are parts of Africa and parts of India in which similar sets of conditions have given rise to similar problems, solutions for which are being sought by very similar, or at least parallel, means. The I. F. S. has been condemned to death as part of a political policy, but it is still by no means dead, either in itself or in the traditions which it is still actively engaged in developing for the guidance and with the help of its successors. In one matter, however, few in India would probably be found to agree with Mr. Oliphant. That is, in his apparent assumption that the principal function of a forest working plan is to regulate fellings. Surely this is in reality only one of the purposes of a good plan; and in some may be (as apparently would often be the present case in Nigeria) of relatively minor importance. A forest working plan might perhaps with advantage be called a management plan. It is intended to weigh and give correct precedence to all the factors affecting the particular estate with which it deals. To fulfil its purpose it should accurately record the assessment of these various factors at the time it was written, in as much detail as possible: should indicate the lines on which it considers that progress is desirable; should assess again the possibilities of putting such desirable progress into practice; and finally prescribe the ways in which this is to be attempted. It serves the dual purpose of briefly summarised past history and of detailed proposals for future development, thus providing a powerful aid to ordered, instead of erratic, progress. Apparent approval of general rural planning, but not of the more detailed planning, essential for continued orderly management for the forests which should be an important part of any properly-planned rural area, is difficult to understand.

Mr. Brasnett, in his *Finance and the Colonial Forest Service,* has outlined some of the ways in which small forestry units are handicapped in getting a sound forest policy installed or, worse still, in maintaining continuity in such a policy. Some of these difficulties, it may be hoped, will be mitigated by the general growing acceptance of the need for rural planning, provided, of course, that the essential place of forests in such planning gets proper recognition. In others—and particularly in matters of finance—there is great danger of continued trouble. Possibly my experience has been unusually unfortunate, but the fact that a Government has approved and published a (management) working plan seldom seems to prevent its more or less complete mutilation by lopping the financial provisions, leaving only a truncated remnant. This ruin may even become a positive danger, through the continuation of exploitation for which the justification in compensatory expenditure has been withdrawn. Such repudiations; on pleas of financial stringency, slumps and so forth, are facilitated by the fact that the funds needed to work a plan are put up for consideration by Government simply as items in a general budget; unattractive, if not repulsive, limbs amputated from the trunk of which they are the hands and feet. Until every approved working plan is treated as a definite contract with legal status, such hindrances are likely to continue. This use in working plans has seldom been stressed, but may be of increasing importance. Such a document tells a Government exactly to what it will be committed as a practical sample of its forest policy and its acceptance, including its financial obligations, for the term of years during which it is to be current, should remain inviolable at least in all essentials; modifications being only undertaken with the solemnity due to a definite repudiation of stated policy. Mr. Brasnett also refers to other less fundamental disadvantages of isolation: for instance, to take a minor point, in the possibility that plans may be made to

develop a market just at the time when others, more favourably situated, are maturing similar plans. For all of these Sir Alexander Rodger suggests a remedy, in his *Forestry in the Colonies,* by co-ordination under Inspector-General of Forests. Here, again, please remember that, according to the present political programme India will soon be a large group of autonomous Forest Services, linked only by such inspections from the central organization and by such advantages of a central education for their members as their local governments may care to provide. It was Emerson who said, "the height of the pinnacle is determined by the breadth of the base." This can be translated, into terms of forestry, as an axiom that it is the degree of intensity of development in the primary units which should regulate the simplicity, or complexity, of the co-ordinating machinery. A thousand square miles of degraded country, referred to disdainfully by its administrators as jungle or bush, hardly ever, if at all, visited by any one of education or intelligence higher than the local inhabitant, who is himself in his own way perhaps almost as degraded as the land he lives on, cannot support and does not require a very complex organization to insure progress instead of continued retrogression. The same thousand square miles, at a considerably later stage in development, brought under an elaborate system of contour strip cultivations, controlled rotational grazings and creation of plantations with several highly qualified and, therefore, expensive managers in charge, may be changed from incipient failure to success by an appropriate organization for pooling experiences and bringing laggards into line with the more progressive units. A period of war is generally marked by much increased activity in ways neglected during peace, *e.g.*, agriculture in England. Demands for timber for war purposes have almost certainly made possible, or imperative, the organization of exploitation in many forest areas all over the Empire which during peace were unworkable, because exploitation could not be made profitable. I suggest that a second axiom might well be that one test of a sound organization is its capacity for smooth change, whether in expansion or contraction. Any organization truly sound in peace should be capable of expansion to meet the needs of war, even though their sudden imposition may make it strain and creek at first. Perhaps, too, this war, of such size, will convince all, beyond argument, that a change from peace to war, or *vice versa,* is really a gradual process to which human organizations can and should be arranged to respond. In India before the war there was a growing opinion among foresters that the development of the primary forestry units had already outgrown the super-structure. There is also a very general regret that a new improvised organization was added, to cope with war demands, instead of expanding the existing one on the framework which had already proved its worth and was quite capable of simple adjustments for expansion. These additions could then have continued their useful purposes after peace without a break, subject, of course, to such contractions as future circumstances showed the need, thus avoiding the probable dispersion and loss of a mass of valuable experience and data gained in meeting the expanded demands of war.—*The Empire Forestry Journal, Vol. 22, No. 2, 1943.*

REAL SPORTSMEN DON'T WASTE GAME

BY HENRY H. GRAHAM

Some time ago, while fishing a beautiful trout stream in the mountains, I stumbled onto an automobile camping party consisting of three men. With them were two sprightly setter dogs. As I called out a cheery greeting, I beheld a sight that made my blood boil. One of the men threw out two plump spruce grouse for the dogs to eat. Naturally, the animals attacked them savagely for grouse flesh is as highly esteemed by dogs as by human beings.

When he saw me the camper looked a bit sheepish, but he quickly regained his composure and became half apologetic.

"Dogs have to eat, you know," he said, "and none of our party likes wild game."

Instead of discussing pleasant subjects as I had fully intended, I said rebukingly: "Do you think it is quite fair to shoot game when you have no intention of using it yourselves?"

A flash of anger crossed his face. "We have hunting licenses," he informed me. "And the season's open."

"Very true," I retorted, making no effort to be cordial. "But you could just as well have brought plenty of canned dog food along. That's a perfectly balanced ration. Don't you have any table scraps?"

"Oh, yes. However, the dogs prefer fresh, uncooked meat, and anyhow, feeding those grouse to them is better than letting them spoil. We don't care for grouse as food, as I just said."

"I don't agree with you at all. It is little short of criminal to feed fine game birds like those grouse to dogs. If you don't care for wild game youselves and can't give it to others you shouldn't hunt. Personally, unless I can make good use of what I get I don't hunt or fish. I just can't bear to see fish or game go to waste. Many a time I have refrained from hunting or fishing simply because I had no outlet for the fruits of the chase. Don't you think that creed should be adopted by all true sportsmen?"

The other man was thinking hard. It was apparent that he had never regarded the matter in that light nor was he highly proud of himself.

"I guess you're right, Mister," he finally admitted. "I'm not doing much for the cause of game conservation, am I?"

"No, you're not," I assented bluntly. "It makes a fellow mad to see dogs wolfishly consuming a pair of fine grouse. Most people think it a poor policy to feed wild game to hunting dogs anyway. It may cause them to eat the birds you shoot instead of retrieving them."

I don't believe those fellows will feed any more game to their dogs. No doubt they did not mean to be unsportsmanlike; it was largely thoughtlessness on their part. But the vicious practice should be condemned in vigorous language.

Many years ago huge piles of dead sage hens, fifty or more to a pile, were found by game wardens in the brushland areas of the far west. Hunters had shot them, heaped them up and abandoned them. Not only did they exceed the bag-limit many times over but made no use whatever of the kill. Such outrages, perpetrated on a wide scale, no doubt, had a great deal to do with making extended closed seasons on this species of grouse necessary.

One day while duck hunting I came upon the blind of another shooter. He greeted me cordially and invited me to share his carefully-constructed position.

"The ducks are flying well," he said. "I've had a lot of fun."

"Evidently," I agreed. "You'll have a good bunch of birds to gather up when you quit for the day."

Fully eight ducks lay sprawled on the shore mud between the blind and the water.

"Oh, I don't intend to take any of them home," he hastened to say. "I shoot merely for sport. I don't like duck as food at all."

"You mean to say you plan to let all of these ducks just lie here and rot or be devoured by hawks?" I demanded.

He nodded. "Sure. What else can I do when I don't want to eat them? None of my friends like ducks, either. And it's one whale of a job to dress them. But it certainly is sport to watch them crumple in mid-air."

"I agree with you there. But I don't think it right to shoot game when you don't intend to make any use of it. Wild life is part of our heritage and should be conserved, not wasted. Instead of leaving those birds here why don't you give them to some charitable institution like a children's home or a county farm for old people? Such places welcome a variation in the diet and would probably be grateful for the ducks."

He sighed and hesitated before replying to my suggestion. At last, "I'm a mile from my car and packing them will be hard work, but I'll do it. I can see your point. Since I have the fun of shooting them it's no more than fair that I should dispose of them to some good purpose."

Every hunter and angler who prides himself on being a sportsman should do his full share in the battle for conservation, shooting or catching no more than he needs and observing the laws. Unless this is done future generations will never know the joy of taking game fish from a stream or seeing a plump mallard splash into the water in front of a blind. Present-day hunters owe such consideration to the millions of sportsmen yet unborn.—*Forest and Outdoors*, February, 1944.

INDIAN FORESTER

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UNDERGROWTH IN TEAK PLANTATIONS AS A FACTOR IN REDUCING DEFOLIATION

By A. H. Khan, I.F.S. and P. N. Chatterjee, D.Phil.

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Introduction

The Branch of Forest Entomology has devoted a considerable amount of time to the problem of how to control the teak defoliators (*Hyblæa puera* and *Hapalia machæralis*). Under the direction of C. F. C. Beeson repeated surveys of the insect fauna in the teak forests of the C. P., Madras, Bombay and Coorg were made between 1925 and 1941 (when he retired) and it was proved that the chief controlling factors were climate and parasitic and predaceous insects. The parasites, of which a large number is recorded, are either specific, attacking one host species only, or polyphagous with a varied selection of potential host species, most of which live on plants other than teak and are therefore at a disadvantage in pure teak plantations. Beeson (1941, *Forest Insects*) advises the encouragement, as undergrowth in otherwise pure teak stands, of certain plant species that are beneficial in so far as they support caterpillars on which the polyphagous parasites can multiply. The presence of these plants would be of special value for maintaining a fairly high incidence of parasites if they were in leaf (and fed upon) at periods when teak defoliators are scarce, such as during the leaf-fall of teak and the cold-weather months.

In 1942 it was decided, if possible, to test the proposition in the field and a project was put into operation at Tithimatti, Coorg, from June, 1942 to June, 1943, taking advantage of the opportunity provided by current work on the problem of teak defoliation. The purpose of this paper is to present the results of this investigation.

Object of the Investigation

The primary object of the investigation was to determine how far the natural control exercised by the parasites of the teak defoliators in plantations with an abundant undergrowth of beneficial plants differed from the parasitism in plantations with a scanty growth of these plants.

Selection of the Areas

The ideal would have been to have in the same locality two isolated areas of teak of the same ages, one pure and the other with an abundant undergrowth of the desired species. In fact the nearest approach that could be found was in Tithimatti, Coorg, where the following two areas were selected for the investigation:

(*i*) A well-defined block of about 350 acres with 22 to 25-year-old teak planted in small groups with an abundant admixture of miscellaneous species of parasite-supporting value. This type of plantation is locally known as a "Y area."

(*ii*) A compact area of about 400 acres of the pure plantations composed of six plantations ranging from 5 to 15 years in age with a scanty undergrowth of the miscellaneous species. This area is about two miles from the Y area as the crow flies.

Organization of the Work and Methods

The work was carried out under the direction of J. C. M. Gardner, Forest Entomologist.

A field insectary was maintained at Tithimatti, Coorg, from June 1942, to June 1943, under P. N. Chatterjee with two field assistants, one forest guard and five coolies. The Coorg Forest Department provided the building for the field insectary and co-operated throughout the working period.

The collection of the larvæ of *Hyblæa puera* and *Hapalia machæralis* and of the defoliators of the miscellaneous plants from the above areas was made at random, and each day's collection was reared separately by species for each locality. Five men were engaged for the collection under supervision throughout the period, and the programme of the daily collection was so regulated that, as far as possible, equal areas were covered in the two types of forest during each weak.

The work involved rearing of several thousands of the caterpillars of teak and other plants. In addition an ecological survey of the flora was made in correlation with the defoliator parasite complex. During the course of the investigation nearly 17,000 parasite specimens of the families *Ichneumonidæ, Braconidæ, Chalcidae* and *Tachinidæ* were bred at the field insectary, and identified at Dehra Dun at the laboratory of the Forest Entomologist where the data were finally collated and analysed.

Summary of Observations

This will be dealt with for the two chief teak defoliators, namely *Hyblæa puera* and *Hapalia machæralis,* separately.

HYBLAEA PUERA

Incidence of Defoliation.—A heavy attack of this defoliator broke out in May-June, 1942, causing severe defoliation in the pure plantation but the mixed teak plantations of the Y area remained practically free from attack; only 23 larvæ of *puera* could be collected from the latter area in spite of a careful search by a party of five collectors for 19 days in June and July. The attack in the pure plantations subsided as usual with the increase of the rainfall in July, and thereafter the defoliator remained scarce in both types of forest up to November, and was not seen in any stage from December to March. In April, 1943, it again appeared in very small numbers and the attack continued to be low in both types till the departure of the field party in June, 1943.

Parasitism.—The parasitism figures of *puera* in 1942 during the epidemic period in June and the post-epidemic months of July and August are of particular interest and are shown below against the numbers of larvæ collected and bred from each type of forest.

Type of forest	Month	No. of days spent in collection	No. of larvæ collected	LARVAL PARASITISM PERCENTAGE										
				Specific Parasites						Polyphagous Parasites				Total
				No. of larves bred on which parasitism based*	*Apanteles* sp. 1	*Apanteles* sp. 2	*Dioctes gardneri*	*Dioctes* sp. 3	*Winthemia* sp. 1	*Sturmia inconspicuella*	*Actia hyalinata*	*Carcelia modicella*	*Elasmus hyblææ*	
Pure Teak ..	June ..	12	3,593	023	2.9	0.9	34.9	0.1	0.9	19.3	8.6	0.6	0.1	68.3
Y Area ..	" ..	9	22	2	..	..	..	..	..	100.0	..	..	..	100.0
Pure Teak ..	July ..	16	19	16	..	..	..	..	..	87.5	..	..	..	87.5
Y Area ..	" ..	10	1	1	..	—	..	..	..	100.0	..	..	..	100.0
Pure Teak ..	August ..	15	20	3	..	..	..	..	..	66.7	..	..	..	66.7
Y Area ..	" ..	10	Nil	..	..	..	..	..	..	..	..	..	..	..

* The difference between this and the preceding column represents larvae lost or dead from unknown causes.

The above analysis brings out the following points on the question of parasite efficiency in the two types of areas.

(*a*) *Pure plantations*:

(*i*) The parasites were unable to check the pest from multiplying to epidemic numbers in June.

(*ii*) The specific parasites had a good share in the control at the culmination of the epidemic in June, but disappeared entirely from the scene with the rapid decline of the pest in July, and gave place to the polyphagous Tachinid *Sturmia inconspicuella* which was the only species recorded from *puera* in July and August.

(*b*) *Y area*:

(*i*) The scarcity of larvæ in the area, at a time when an epidemic was raging in the neighbouring pure-teak plantations is striking.

(*ii*) Whether this scarcity was due to the parasite efficiency cannot be said with certainty owing to small breeding from Y area. But 100 per cent. parasitism by *S. inconspicuella* for the few larvæ collected is suggestive of a very high parasite efficiency which may have been responsible for preventing an epidemic in this area.

HAPALIA MACHAERALIS

Incidence of Defoliation and Parasitism before the Epidemic Attack.—This defoliator was extremely scarce in both types of forest from June to September, 1942. During this period a careful search by a party of five collectors for 38 days in the Y area and 55 days in the pure plantations yielded only one larva in the former and 144 larvæ in the latter. The single larva of the Y area did not yield any parasite and the parasitism of the larvæ from the pure plantations was 30 per cent. in June and 50 per cent. in July, chiefly contributed by polyphagous parasites, notably *Trichomma nigricans*. The parasitism in July and September was nil when the pest had become extremely scarce due to the adverse climatic conditions.

The Outbreak of an Epidemic.—This extreme scarcity of the defoliator and its parasites was followed in October, 1942, by the sudden appearance of enormous numbers of moths, a phenomenon that can only be explained by assuming immigration from elsewhere leading to complete defoliation in the pure plantations in Tithimatti and Nagerhole ranges. In the Y area the attack was also severe, but not so complete as to cause a new flush of leaves. When the teak leaves were completely consumed, an acute shortage of food followed and even the tender buds at the growing tips were gnawed, leading to considerable dying back and subsequent forking. The larvæ then climbed down to the undergrowth. The advanced larvæ went into hibernation under the fallen leaves, and the younger larvæ explored the miscellaneous vegetation doing considerable skeletonization notably on lantana and Clerodendron.* There must have been a good deal of mortality due to starvation.

Possibility of Moth Migration.—As already mentioned, this defoliator was extremely scarce in the Coorg plantations from June to September and the sudden appearance of the large swarms of the moths could not be ascribed to normal local multiplication. In order to ascertain the cause of this swarming further, Mr. A. H. Khan, who was touring in Coorg at the time the moths appeared, inspected thoroughly the teak forests of the Tithimatti and Nagerhole ranges with the Chief Forest Officer, Coorg, but could not discover any evidence of previous defoliation to explain this enormous population of the moths. On enquiry from the forest officers of the neighbouring district the D.F.O., Wyanaad, a district adjoining Coorg, reported that an epidemic attack of *Hapalia*

* **H. machaeralis** has never been recorded to feed on these plants normally and attempts to continue the rearing to maturity of some of these larvae on the same plants under laboratory conditions were not successful. Larvae refused to feed on lantana at Dehra Dun when offered no other food.

machæralis causing complete defoliation of teak took place at Kannoth (about 35 miles from Coorg as the crow flies) about a month before the moths appeared in Coorg. The sequence of events of the attack at Kannoth and in Coorg gave strong suspicion that the moths resulting from the larvæ which caused complete defoliation at Kannoth migrated to Coorg. That local dispersal of the moths can be widespread is well known but the long-distance migration of the moths *en masse* has not been recorded or suspected before. The question of the migration of the moths has an important bearing on the control of the pest and requires confirmation by direct evidence and, if proved, will necessitate reorientation of our methods to combat the pest at the source. This observational work requires considerable co-operation from the forest officers and has of necessity been postponed till after the war.

Parasitism during and after the Epidemic.—Parasitism in both types of forest was very low in the early stages of the attack and, before the parasites were able to adjust themselves to this sudden invasion, heavy to complete defoliation had been caused. This attack continued up to the middle of December and was followed up to study the incidence and parasitism of the next generation. The second attack which started in January, 1943, on new flush was very light, probably owing to low fecundity of the moths in the cold weather.

The bulk of the collection during the winter months (December to March) consisted of hibernating larvæ from the fallen leaves and their parasitism was very low ranging from nil to 4.5 per cent. which showed no significant difference between the two types of forest. The larvæ when in hibernation under the fallen leaves are not readily accessible to parasites. The active larvæ collected from green teak leaves have given a better idea of the parasitism in continuation of the epidemic as shown in the table below for the two types of forest.

Month	Y Area		Pure planations	
	Specific	Polyphagous	Specific	Polyphagous
October, 1942	17	83	0	100
November ,, ...	4	96	5	95
December, ,, ...	12	88	20	80
January, 1943	0	100	10	90
February ,, ...	87	13	47	53
March ,, ...	46	54	63	37
April ,, ...	47	53	31	69
May ,, ...	24	78	26	74
June ,, ...	0	0	0	0

It will be seen that in both types of areas the polyphagous parasites were dominant throughout the above period except February in the Y area and in March in the pure plantations.

Teak Defoliation and Forking.—The dying back of teak as a result of damage caused to the leading shoots by *Hapalia machæralis* following complete defoliation in October, 1942, was studied in detail at the Nagerhole (Coorg) All-India Teak Seed Origin Experimental Plot (planted in 1940), and supplemented with general observations in the defoliated plantations of Tithimatti range. It was found that the leaders of 52 per cent. teak plants in the Nagerhole plot died back to a length of about 6 to 12 inches within a month after the complete

defoliation (based on a total count of 21,600 *plants of six seed origins*), of which 18 per cent. recovered by May, 1943 (based on a sample count of 360 plants of the six seed origins, giving at the end of May, 34 per cent. as forked. The general observations in Tithimatti showed that plants up to about 10 years old were thus affected, and that older plants did not show any appreciable dying back or forking. The degrade in bole value in forking in young plantations leading to permanent deformation in most cases is probably more serious than the simple loss of increment. This emphasises the necessity of control measures from the very first year of the formation of the plantations..

Conclusions and Suggestions

This investigation has confirmed our previous findings that the polyphagous parasites play a very important part in the control of the teak defoliators, and has proved that normally the parasite efficiency in the teak areas with an abundant growth of certain miscellaneous plants, which support alternative hosts of the parasites, was distinctly better than in the pure plantations. The sudden invasion of the *Hapalia machæralis* moths from outside in October, 1942, however, upset the balance between the pest and the parasites, causing complete defoliation everywhere.

The investigation has led to the addition of many species to our list of beneficial plants, a revised list of which has been prepared for the use of the Coorg Forest Department. In the Coorg forests there is normally a fairly good mixture of the entomologically beneficial species before the area is felled and planted up with teak. Our survey of the miscellaneous vegetation in the teak plantations from the year of formation has shown that, as a result of intense burning in the first year, a great majority of stumps are killed outright and there is hardly any entomologically useful vegetation left in the plantation worth speaking of. A few coppice shoots spring up here and there and some natural seedlings also come up but, all told, they are so few and poor in development that they cannot be expected to exercise any substantial controlling effect on the teak defoliators. There is a chance for quite a number of natural seedlings and healthier coppice establishing themselves if they are recognised as useful and are not cut out indiscriminately in the tending and thinning operations. Even then they are not likely to come up to much until the plantation has undergone at least two thinnings. In the meantime the plantations continue to suffer from defoliation and give a chance to the pest to multiply to epidemic numbers endangering the whole locality. It must be pointed out that the younger plantations up to about 10 years in age are most susceptible to the serious damage of dying back and forking as a result of heavy defoliation, depreciating the timber value of the crop considerably.

It is, therefore, necessary to find out ways and means to maintain and encourage from the start as much of the original useful mixture as is compatible with silvicultural principles. One of the suggestions recently made to the Coorg Forest Department was to save a certain percentage (say 10 per cent.) of the coppice stumps of the beneficial species from burning, and maintain the coppice growth below teak canopy with the encouragement of whatever natural regeneration comes up normally in the plantations. This would probably involve a sacrifice of some teak stakes in the initial planting but if this method is successful its beneficial effect on the whole plantation might in the long run outweigh the initial loss of the teak stems. The Chief Forest Officer, Coorg, has agreed to give this suggestion a trial by reserving the desired number of entomologically useful poles (which are usually unmarketable) before felling, and cutting them for coppice after a controlled burning was completed. The Forest Entomologist will be glad to receive any criticism from the forest officers on this suggestion.

LIGNUM VITAE

(With Some Remarks Regarding Red *Kutch*)

BY E. L. P. FOSTER, I.F.S.

(Utilization Officer, F.R.I., Dehra Dun)

Mr. John R. Callaham has written an exceedingly interesting article in "Chemical and Metallurgical Engineering" for May, 1944 on *Lignum-vitæ*. This is particularly interesting to us at the moment when it appears that India has a good substitute in *Acacia catechu* var. *sundra*, which first came to the notice of marine engineers under the name of "Red ebony," but which, as pointed out by Dr. Chowdhury, Officer i/c Wood Technology Section, F. R. I. & C., should be known in future as "Red Kutch."

Mr. Callaham states that *Lignum-vitæ* is the hardest, heaviest and closest-grained wood known. It comes from the West Indies and the Northern coast of South America, and has been known since 1500 A.D.

Before the war it was turned into many items such as mallets, castors, dowels, bearings, bushings, spools, pulleys and guides.

With the war, *Lignum-vitæ* immediately took its place high on the list of priority materials, being of great value in ship construction. Its self-lubricating properties, resistance to salt water, and great compressive strength making it excellent for segment bearings in propellor-shaft assemblies: it has been used for this purpose in over 1,000 Liberty ships.

It replaces copper alloys. Long before the war it was replacing brass, bronze and babbitt metal for bearings. It is expected that its post-war uses will increase.

Lignum-vitæ heartwood is exceedingly hard and the grain is closely interwoven, giving a density of 72.23 lbs. per cu. ft. It has the ability to withstand working pressures of 2,000 lbs. per sq. inch.

The important self-lubricating quality comes from its high resin content, which amounts to 30 per cent. of its volume. This resin is insoluble in water.

The following properties of the heartwood are given:

Specific gravity ...	1.17 to 1.32
Lbs. per cu. ft. ...	72—82
Hardness, Mohs scale (approximately) ...	3—4
Modulus of rupture lb. per sq. inch ...	11,200
Max. crushing strength lb. per sq. inch ...	10,480
Max. working pressure recommended lb. per sq. inch	
Resin content, per cent. of volume (average) ...	28—30
Max. recommended dry working temperature (deg. F.)	150
Diameter of heartwood (inches) ...	4—24
Odor ...	Balsamic.

The author gives a most impressive account of a test in which exactly similar pullies of brass and *Lignum-vitæ* were revolved a million times, at the end of which period the brass pulley centre hole had increased 1/16 inch, while the *Lignum-vitæ* pulley had suffered only a few thousandths of an inch wear.

Lignum-vitæ, like all woods, is subject to working. After an article is finished it should be coated with shellac or paraffin.

Lignum-vitæ is not suitable for use where the applied or frictional heat generated is over 150°F., unless operating in contact with water or some other liquid. Nor should the wood be used under strongly acid conditions.

The author describes the chemical properties of *Lignum-vitæ*. He also gives the

following very interesting list of uses of *Lignum-vitæ* wood in chemical and Process Industries:

Submerged phosphorus pumps	bearings.
Vinegar-tank agitator	..bushing.
Weak sulphuric-acid tanks	..foot bearings.
Powder-shell loading	..tamper.
Beer tanks	..bearings.
Ammonium-sulphite pumps	..bearings.
Soap-mixing machine	..rollers.
Tumbling magnesium in oil	..balls.
Electroplating tanks	..supports.
Fruit-cutting machines	..guides.
Alkaline cleaning solution	..drain board.
Drug-mixing vat	..studs.
Copper chloride pumps	..bearings.
Bleachery equipment	..squeeze rolls.
Food-handling equipment	..bushing.
High-pressure relief valves	..balls.
Rock-crushers	..thrust collars.
Cosmetic-cream vats	..paddles.
Beer pumps	..piston rings.
Roll-crushers	..rolls.
Water-treating tanks	..foot bearings.
Chromic-acid-plating baths	..spools.
Pharmaceutical equipment	..friction block.
Vinegar pumps	..bearings.
Shell-loading conveyors	..rollers.
Milk tank agitators	..bushings.
Dye solutions	..bearings.
Food canning equipment	..bushings.
Incendiary mixing barrels	..balls.
Dye machinery	..plugs.
Exhauster valve	..guides.
Rubber squeeze roller	..bearings.
Deep well pumps	..bearings.
Slurry agitator tanks	..guide bearings.
Boric acid solutions	..guide bearings.
Hydrofluoric acid pumps	..packing.
Plating equipment	..blocks.
Cutting compounds	..rollers.
Salt brine vats	..bearings.
Cotton bleach tanks	..guide bearings.
Aluminium acetate tanks	..bearings.
Acid mine waters	..balls.
Textile machinery	..bushings.

In conclusion it may be of interest to give the following comparative statements of what strength figures have been obtained by the Timber Testing Section for Red *kutch* and the strength figures for *Lignum-vitæ* already given.

	Lignum-vitæ	*Red kutch.*
Specific gravity	.. 1·17 to 1·32	1·01
Weight per cu. ft.	.. 72—82 lbs.	71 lbs.*
Max. crushing strength	.. 10,480 lbs. per sq. inch †	14,900 lbs per sq. inch.
Hardness end and side as compared to teak	.. 414 per cent.	407 per cent

It must be appreciated that the Timber Testing Section has not yet had an opportunity to test more than a very few samples. These figures are, therefore, tentative.

It will be seen that there is considerable resemblance. In addition, one of the first characteristics in Red *kutch*, commented upon by Dr. Chowdhury, was the very high quantity of resin contained in the timber: this has not yet been estimated.

GRASS THAT FIGHTS SNAKES AND MALARIA

BY M. B. RAIZADA, M.SC.

(*Asst. Forest Botanist, F.R.I., Dehra Dun,*)

A small quantity of seed of this grass, which is said to drive away mosquitoes, ticks and snakes, was received in July 1943, from the Agricultural Commissioner with the Government of India.

The following extract, although it sounds fabulous, from the *Planter's Chronicle* for December, 1941, received as an enclosure with the seed packet, and reproduced here *verbatim*, describes the qualities and virtues of this grass:

"A grass with discriminating tastes, which co-operates with man in a most satisfactory fashion, has been discovered by Dr. Edward Morgan of Caracas, Venezuela. This strange grass drives away mosquitoes, ticks and snakes, and at the same time provides luxuriant pasturage on which livestock thrives and grows fat.

The plant accomplishes its beneficial purpose through an oily substance which exudes from its stems, especially during the blossoming period. It also has a peculiar, penetrating and pleasant odour, especially in the early morning before the dew is dry. The oil is so heavy a man can get his boots greased by walking through it.

Dr. Morgan, an English physician, first reported his discovery to a London medical society about a year ago, when a proposal to establish a Jewish refugee centre in British Guiana was violently opposed on the ground that the refugees could not endure the tropical conditions. Thousands of square miles of northern South America and Central America may be opened to northern European colonization through the finding.

The great curse of large areas of the country is malaria. This disease, Dr. Morgan says, keeps the population of Venezuela down to about 4,000,000 although there is enough fertile land to support ten times that number.

Malaria-bearing mosquitoes swarm in tremendous numbers during the rainy season, from April to November. This is the time the grass is green—the period when it is most potent as a shield against pests. Hardly a single mosquito can be found over a pasture sown with it. So powerful is it that cattle heavily infested with blood-sucking ticks are freed of them in a few days after being turned into such a pasture. Even the dreaded bush-monster, most venomous of tropical snakes, will not come within smelling distance of such a field.

According to the Pan-American Sanitary Bureau, the grass is one of the richest of all feeds for horses, cows and mules. The plant is especially adapted to dry soil, and consequently the best prospects for its use are afforded by Venezuela, Columbia, Ecuador, the three Guianas, and possibly northward to central Mexico.

The grass will yield a heavy hay crop. It also drives away the big, fierce bachacho ants which can invade and destroy a cornfield in a few days.

"It should be planted," Dr. Morgan says, "around every home in the tropics."—*American Weekly Magazine*, December, 1941."

The seed was sown in the beginning of July, 1943, in pans and although it did not germinate freely, a good number of plants were raised and transplanted in a bed. The grass grew luxuriantly and shewed signs of flowering in January 1944, but, owing to very low temperature, it did not flower well enough till about end of March, from which time onwards it flowered profusely until beginning of June 1944. The seeds are now ripening and will soon be ready for collection by end of June. The grass has been identified as *Melinis minutiflora* Beauv., a native of tropical Africa. As great interest is being evinced in its cultivation by various provincial agricultural departments and others, the following information, which has been collected from various sources, is given for the benefit of those interested in its introduction:—

The qualities referred to above were attributed to this grass as early as 1921 by Mr. M. T. Dawe when he made an agricultural survey of Angola. The subject of stock-raising has always proved difficult in western tropical Africa and Mr. Dawe was consequently devoting much of his attention to this object. In the course of his travels he noticed a grass which was sought after by domesticated animals for fodder and yet at the same time appeared to be inimical or, at any rate distasteful, to the tsetse fly, a scourge against which little headway has so far been made in West Africa.

That the natives of the Portuguese Congo had a knowledge of its insecticidal and preventive properties is shown by their practice of making nests for their setting fowls and using it as bedding for dogs when about to give birth to young as it prevents the fowls and dogs being attacked by fleas. They also use the fresh grass for cleaning their clothes made from the fibre of the Raphia palm. In South America the grass is known to be repugnant to ticks and cattle fed on this grass are reported to be much less subject to ticks although the meat and milk of such cattle has not any taint or suggestion of the characteristic odour of the grass, which is not unlike curry-powder. The properties which render it objectionable to the tsetse fly are not only the strong odour of the viscid drops of oil exuded by the hairs on the leaf sheaths but also that they act, it is said, in the capacity of a "fly-catcher," and, as Mr. Dawe remarks, if a big fly like the tsetse be ensnared, how much more would smaller flies be entangled, such as the mosquito, which would tend to shelter in the shady nooks of the grass during daytime.

In contrasting the effect of this grass with citronella grass, Mr. Dawe refers to the experiments he carried out in Uganda, where the planting of this grass, but perhaps more especially the clearing of the ground concomitant with the planting, did appreciably diminish the tsetse fly, and again in Ceylon where animals working among and feeding on citronella grass escaped an epidemic of rinderpest which spread over a large part of the island. Since citronella grass, whose aromatic and oily properties are only noticeable when the leaves are bruised, has proved of service, he maintained that experimental planting of this grass, in which the aromatic and viscid oil is exuded and exposed, is well worthy of serious consideration.

The oil of the grass was examined at the Wellcome Chemical Research Laboratories by Dr. T. A. Henry whose results may be summarised as follows: The oil is exuded from glandular hairs, which are easily visible on the stems of the fresh plant. It was brown in colour, had a consistence similar to that of soft paraffin, showed a tendency to crystallise when the vessel containing it was placed in ice and salt. It was acid to litmus and had the characteristic odour recalling that of cumin seed and similar to the aroma of the fresh plant. The fresh plant yields about .001 per cent. of volatile oil which, so far as could be judged, consists of free acids and esters with possibly some phenolic substance. The constituent to which the characteristic odour of the plant is due is not an acid or phenol since it persists after these constituents have been removed or decomposed.

The genus *Melinis* consists of about 16 species, all of which are confined to tropical continental Africa except perhaps *M. minutiflora*. The question arises whether it is really indigenous in America or introduced. Opinions differ but it appears that if not truly indigenous in Brazil it was probably carried there in early days by the slave trade. It is an important fodder grass in the tropics of both hemispheres. In Angola it goes under the name of "Efwatakala grass." It has during recent years been cultivated in Rhodesia and South Africa under its common name "Molasses grass." It is hairy and viscous with a strong odour perceptible at a distance, especially in the early morning hours. The viscid exudation disappears on the dry material. It is readily eaten by cattle in the young state but should be cut for green fodder or hay before seeding.

. Analysis indcates that the hay is a fodder of fair quality. It is useful as a cover and mulch, and to suppress other weeds.

Insects or their larvæ become entangled in the secretion, and it has been suggested as a deterrent to ticks and tsetse fly; it is also said to repel reptiles and carnivorous animals. Experiments at Kusami Agricultural Station in the Gold Coast have shown, however, that this grass had no effect in preventing the breeding of mosquitoes (Hunter in *Gold Coast Dept. Agri. Bull.* No. 7, *Year-Book*, 1926, 49). The effect on larval ticks can be observed in a test tube, the action of the glandular hairs being purely mechanical. That the tsetse fly with a different biological history can be so repelled is open to doubt.

A detailed description of the grass (after Stapf and Hubbard) is appended below and a good black-and-white plate may be seen on p. 570 of *Flora of West Tropical Africa*, Vol. II, by Hutchinson and Dalziel.

Melinis minutiflora Beauv. Agros. 54, t. XI, f. 4. A strong-smelling viscous perennial; culms 1—3 ft. long, erect or geniculately ascending from a prostrate many-noded base, up to 6 ft. long, terete, slender or stout, sometimes rooting at the lower nodes; node pilose to villous. Leaves sparsely and softly to coarsely pilose with the blades tomentose with white spreading or appressed hairs, finely tuberculate; sheath short and tight below, increasing in length upwards and becoming looser and overlapping, finely striate; ligule reduced to a short ciliate rim; blade linear to linear-lanceolate from a rounded base, 2.5—7 in. long, .2—.65 in. wide, rather rigid; margins sparsely or densely ciliate and scaberulous. Panicles linear to ovate-oblong, more or less dense and contracted, 4—12 in. long, rarely shorter, erect, rigid or flexuous, usually purplish; branches erect, 1—3-nate, finely divided; branchlets and pedicels capillary, flexuous, puberulous, the latter very unequal up to .2 in. long. Spikelets narrowly oblong .1in. long, very minutely bearded at the base, purplish. Lower glume very minute, oblong, obtuse, nerveless; upper equalling the spikelet, linear-oblong, 2-lobed with the lobes rounded or obtuse, 7-nerved. Lower floret barren; lemma narrowly oblong, equal or slightly shorter than the upper glume and of similar texture, 2-lobed with a purple flexuous awn .3—.5 in. long; palea o. Upper floret hermaphrodite; lemma ovate-oblong, glabrous, hyaline, obscurely 3-1 nerved, minutely 2-fid; palea of similar shape and texture; anthers .15 in. long.

If, however, the various qualities of this grass as herein outlined come up to expectation, its introduction in our country will be a work of the highest humanitarian importance; for in place of a decreasing population (from malaria and snake-bites) and vacant lands will grow up a healthy and thriving nation, as well as cattle industry which should contribute materially to the economic development and prosperity of this country.

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DIMINISHING STOCKS OF FISH IN THE KUMAON LAKES

By Major A. St. J. Macdonald

From conversations with anglers who have fished these lovely lakes regularly over a period of years, one is left with the impression that the fishing has steadily deteriorated, both in the size of fish and the numbers taken on fly and spoon; this is further borne out by talks with old shikaris and boatmen.

No attempt has been made at restocking with new blood for the past 25 years to my knowledge; surely a comparatively easy matter with the Kosi and Gola rivers near at hand, and the old Trout Hatchery at Bhowali lying unused. It remains a matter of speculation if the fish in Sath and Naukatia Tal breed fertile spawn, as there is no inlet or flow of water so necessary for breeding fish.

I have observed in June of both 1942 and 1943 that all the fish taken were "cock" or Milter in milt; this was over 14 days' fishing and with some 60 odd fish, no exceptions and no hen fish. It is difficult to arrive at any conclusion, except that it is a definite spawning period but where are the hen fish? These observations are for Sath Tal and Naukatia Tal.

Bhim Tal is more fortunate in having a stream feeding it throughout the monsoon and affords an excellent breeding ground, though restocking would further improve the fishing.

All the Mahseer I have seen in the lakes are *Barbus Tor Putitora* (Hamilton). If the Bhowali hatcheries were utilised and that game and beautiful fish *Barbus* (*Lissoshilus*) *hexagonolepis*, better known as the Katli or Boka in Assam, were introduced, the whole position of the fishing of these lakes might be revolutionised.

The Boka grows to 20 lb. or more in rivers, takes fly better than spoon and likes the quiet water under trees and near stones to the fast runs so beloved of his giant cousin. I have taken the Katli in the Girwa and Bagmati in Nepal so that conditions should not be a difficulty.

Then there is the sporting little *B. Bola* or, as he is better known, the Indian Trout, with equally game cousin, *B. Tileo,* which also grows to two pounds. Both *B. varna* and *B. varila* are resident in both Sath Tal and Naukatia Tal and also in Bhim Tal so that even though *B. Bola* gobbles up anything his own size it should be tried out, and a change of diet will develop with the changed environments.

These lakes are now administered by the Tarai and Bhabar Authority and are yearly drained where possible for irrigation purposes besides which a small yearly income must be realised from fishing permits and boat hire. If a small annual grant were made for restocking, the fishing would soon improve and, as I have heard it said, give far better sport than the trout of Kashmir and Kulu. And if the the Boka is once established, these lakes will become an "Angler's Haven."

THE ANDAMAN FORESTS AND THEIR REGENERATION—III*

By B. S. CHENGAPA

(Formerly Assistant to the Chief Forest Officer, Andamans)

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CHAPTER VI—REGENERATION OF WET EVERGREEN FORESTS

METHODS EVOLVED FOR SEMI-DECIDUOUS FORESTS FOUND NOT IMPLICABLE

Before the beginning of 1933, it was realised that regeneration of wet evergreen forests, and also of forests with *Dipterocarpus* predominating could not be secured by the treatment evolved for the other types of forests. In fact by the uniform application of this method, it was found that the evergreen patches, usually found dotted about in other types of forests, were converted into deciduous forests, as the resulting regeneration, though complete, was purely deciduous, mostly white *dhup (Canarium euphyllum), papita (Sterculia alata), Badam (Terminalia procera)* and white *chuglam (Terminalia bialata)*. Experiments were, therefore, carried out in wet evergreen forests (Type 5) to find out the best way of securing their regeneration and their subsequent development.

LONG ISLAND GURJAN EXPERIMENT.

This island is covered completely with semi-deciduous jungle fast heading towards climatic-climax formation. *Dipterocarpus alatus,* the only *gurjan* found in this island, is the predominating species.

Thirty acres in this island were demarcated and treated as follows:—

In January, 1933, the canopy was raised to 40 ft. from ground level by cutting all undergrowth, and in April the slash was burnt. The trees flowered profusely in January but paraquets swarmed round like flies and destroyed both flowers and tender fruits, and allowed only a few to reach maturity and the soil, germination was therefore poor.

The advance growth of *gurjan,* invariably found under mother trees, in spite of precautions, died of excessive heat produced by the conflagration while burning the brushwood. However, profuse regeneration of *koko, padauk,* white *chuglam, badam (Terminalia procera)*, etc., other species came up and occupied the area competely. But before they reached six inches in height, they were completely destroyed by deer. Therefore, attempts to restock the area with *gurjan* seedlings from the adjoining jungle were made, but these failed to establish themselves. Deer did not touch any *gurjan* seedlings while they had more succulent plants to eat. After these were exhausted any *gurjan* seedlings that survived the heat and also all those that germinated after the treatment were browsed heavily. This experiment was, therefore, abandoned.

GUITAR ISLAND EXPERIMENT.

This island was similarly completely covered with semi-deciduous forests (it has since been completely regenerated) fast heading towards climatic-climax formation. *Dipterocarpus alatus* was the predominating species

* Parts I and II of this article appeared in the *Indian Forester* of September, 1944 and October 1944, respectively.

and was the only *gurjan* found in this island. Except for the few top-storey trees, like *gurjan, padauk* and *koko,* everything else was completely evergreen.

While examining these islands in May, 1933, for regeneration work in general, about six *gurjan* trees, in about 12 acres, were noticed to have a large number of mature seeds. The undergrowth was at once cut and the tree cover was raised to 40 feet from ground level. But due to past heavy fellings the overhead shade could not be controlled and in many places big gaps were formed. As it was then raining, no burning was possible and the mother trees were felled and removed in June immediately after seedfall. Germination was complete and profuse in June and July and gave a dense crop of seedlings within a radius of 100 feet from the mother trees. A large number of these seedlings were pulled out and planted in places where such regeneration did not exist within these 12 acres. But, in the first break in the monsoon, the transplants and also a large percentage of the germination, especially those on decayed leaf litter, died out. In summer, further casualties occurred among the seedlings that were fully exposed, and it was feared that the whole area as a gurjan experiment would be a failure. However, other species such as white *chuglam, Lambapathi (Sideroxcylon longipetiolatum), Badam,* white *dhup* and *papita* had come up in large numbers and were growing well. *Taungpeing (Artocarpus chaplasha)* seedlings, come up naturally and also similarly planted, were doing equally well. So, even if *gurjan* had failed, this area would still have been completely stocked.

An examination in January and February, 1934, showed that a large number of *gurjan* seedlings were still flourishing. But it was most puzzling that both sickly and healthy plants were found side by side and both in shade and in the open. The sickly plants showed that their root system was diseased and could be easily pulled out. The healthy plants could not be pulled out so easily.

In 1934 and 1935, the young crop was kept weeded and the tree canopy was raised gradually and was eventually completely removed. The whole area was thus completely stocked with *gurjan* forming about 35 per cent. of the crop. Around the stump of the old trees the young crop was pure *gurjan.*

LESSONS LEARNT FROM THESE EXPERIMENTS

From these two experiments it was learnt that: (1) Paraquets should be kept out of the way from the flowering stage.

(2) Burning is definitely harmful in an evergreen area as it is extremely difficult to protect any advance growth already on the ground. Advance growth is a common feature in all evergreen areas, and especially in the case of *gurjan* species.

(3) Initial cutting of 40 feet from ground level is too heavy an opening for the unestablished seedlings of this species.

(4) Deer browse heavily and destroy the plants when they have nothing else more succulent to eat.

Further experiments were accordingly tried in Porlob Island and also in Kyitaung in the Middle Andaman Island.

EXPERIMENT I—PORLOB HILL, PORLOB ISLAND

On Porlob hill, a typical wet evergreen forest, an area of ten acres was treated in January, 1934, by cutting all undergrowth and shrubs up to a height of 10 feet from the ground. The *gurjan* in this area is mostly *Dipterocarpus turbinatus.* The seeding of this species in 1934 was poor; it was, therefore, left to itself. In 1935, the seeding was good and so also germination. The area was completely covered with masses of *gurjan, lambapathi* and red *bombwe* (*planchonia andamanica*) seedlings. Nothing further was done, not even weeding, as this was primarily an experiment to see whether germination of *gurjan* and other evergreen species could be induced. The area was left to itself until it was due for regeneration in the usual course of regeneration work.

In 1930, this area fell due for regeneration work along with 94 acres of wet evergreen

area that was taken up for treatment during that year. It was then found that the plants secured in 1935 were still there, though they were not by any means flourishing. But they had established themselves firmly and a drastic opening up of the canopy in 1939 enabled them to shoot up much faster than the plants in the adjoining area.

EXPERIMENT II—LALTIKRI HILL, PORLOB ISLAND

In 1930 and 1931, when the adjoining deciduous areas were taken up for regeneration work along with 94 'acres of wet evergreen fellings, this hillock, 29 acres in extent, a typical wet evergreen forests, was left alone as the silviculture of evergreen species was very little known then. The only *gurjan* (*Dipterocarpus grandiflorus*) found in this area had mostly been removed in the past fellings. What was left behind was some *ficus*-bound *gurjan*, *Myrstica* and other useless tree-growth. Few seedlings of *gurjan* in occasional patches were also struggling for existence.

Early in 1934, this area was taken up for experiment. The treatment given was that the canopy was generally raised to 20 feet from ground level, except over patches with advance growth of *gurjan*. Over such patches the canopy was raised to 30 feet. In June some germination of *gurjan* was noticed. As this was considered insufficient completely to stock the area, white *chuglam*, white *dhúp* and *papita* were proposed to be planted in July. Before this was done, there sprang a pleasant surprise in the mysterious appearance of *lambapathi* seedlings in large numbers, cmpletely filling up the whole area. It was a mystery, because of the complete absence of any *lambapathi* mother tree within a radius of at least two miles from this hillock. The mystery was, however, soon solved when it was found that the Andaman Imperial pigeons were the mysterious messengers who did the sowing. *Lambapathi* (*sideroxylon longipetiolatum*) fruits get ripe in the dry weather, and these birds feed voraciously on them and pass the seeds undigested. In dry weather they spend their time almost completely in evergeen jungle.

In 1934 and 1935, the tree canopy was gradually raised to 80 feet and was eventually removed. The area was kept weeded regularly. Both *lambapathi* and *gurjan* grew up very well; *lambapathi* was very much faster in growth.

EXPERIMENT I—KYITAUNG—75 ACRES

Kyitaung, a typical wet evergreen forest (hill evergreen) was felled over for extraction early in 1933, retaining carefully selected and well-distributed mother trees. *Gurjan*, unlike *padauk* and other deciduous trees, are usually sound and straight. Therefore, with the only guide of a girth limit of nine feet and over for exploitation fellings, it invariably happens that very rarely any mother tree is left behind. It is especially so in the case of *Dipterocarpus alatus* which formed the predominating species on the lower slopes of these hills. *Dipterocarpus grandiflorus* and *Dipterocarpus turbinatus*, and also *lambapathi*, formed the predominating species on the ridges and higher slopes.

This area was taken up for treatment about the end of 1933, immediately after extraction fellings. As a fair amount of *gurjan* advance growth was found scattered over the whole area, the undergrowth was cut and the tree canopy raised to 30 feet. The mother trees flowered profusely and the paraquets were also there in many thousands. But bush policemen who were stationed here for protection against the *jarawas*—a hostile wild tribe whose only contact with the civilized world is with his arrow usually shot through the chest of some unfortunate man—were detailed to expend their usual quota of ammunition on these birds instead of firing blank to scare away these implacable wild tribes. This had the desired effect; seeding was profuse, rainfall was fortunately timely and germination was, therefore, abundant and the whole area, except for small patches, was one mass of *gurjan* seedlings in July. Besides these, *lambapathi*, red *bombwe* and *taungpeing* also came up and filled up the area completely. Sample patches were counted and as many as 15 to 25

thousand *gurjan* seedlings per acre, besides other species, were found. (This is by no means the average for the whole area.)

The area was kept weeded in 1934 and 1935 and the canopy gradually raised to 60—80 feet according to the requirements of the young crop. It was, indeed, found that heavy opening was necessary once the seedlings had passed one dry season. Casualties were unknown. The whole area was a success beyond expectation and led to its repetition in 1935 on an equally large scale.

EXPERIMENT II—KYITAUNG

An area of 78 acres adjoining the 1934 area was similarly treated in 1935. The initial felling was limited to 10—20 feet from the ground as there was no trace of any advance growth on the area. It was also, unfortunately, a poor *gurjan* seed year. The whole outlook was therefore, very gloomy. However, *lambapathi,* red *bombwe* and also *bakota* (*endospermum malaccense*) came up in sufficient numbers. The area was therefore, kept weeded and the tree canopy raised to 30—40 feet. Fortunately, 1936 was a very good *gurjan* seed year and the rainfall also was timely. *Gurjan* germination was therefore, profuse. Once *gurjan* germination is secured, it has not been found difficult to obtain their development.

CHAPTER VII—STANDARDIZATION OF REGENERATION FELLINGS IN WET EVERGREEN FORESTS

Sir Gerald Trevor, Inspector-General of Forests, in his Inspection Note (February, 1936) observed: "In Kyitaung and Guitar Islands, regeneration areas visied by me, complete regeneration of *Dipterocarpus alatus* and *Dipterocarpus grandiflorus, lambapathi,* some white *dhup* and *papita* has been obtained by clearing undergrowth to 30 feet in 1933 and subsequent rains. Weeding and lightening the canopy from below upwards, 75 acres of *gurjan* have been thus regenerated in 1934 and 80 acres in 1935 and the staff have now demonstrated that they can regenerate an area of deciduous or evergreen forests with no particular difficulty."

The real tropical wet evergreen forests are not very extensive in the Andamans and are, in fact, confined to the hills and ridges and to the eminences that emerge abruptly from the deciduous forests. In fact they are found scattered all over the Islands. A rough calculation for the regeneration scheme in 1939 (a ten-year scheme for the regeneration of the Andaman forests, 1939—1949-50) showed that, out of 11,200 acres, only 515 acres could be classed under this category. However, any wet evergreen forest that came in within the year's allotted regeneration area was successfully regenerated. Thus from 12 acres of experimental area in Guitar Island in 1933, the total area successfully regenerated up to 1940 was 1,670 acres, the highest in one year being 770 acres in 1940. (Figures for subsequent years are not available; records were lost at the time of evacuation.) Though no failures have been experienced so far in regenerating the wet evergreen forests, it cannot be said that the results are conclusive. However, the following rules were evolved as a guide to the marking officer:

METHODS OF EXECUTING REGENERATION FELLINGS IN EVERGREN FORESTS

1. The species of importance in evergreen jungle are *taungpeing, lambapathi, gurjan, jhingan (Pajanelia rheedii), messua, evodia* (now coming into prominence as a splint wood) *bakota* and *lalbombwe.* The seedlings of these, though they eventually disappear, stand shade and suppression to an extraordinary degree. Therefore, in any evergreen area it is not uncommon to see a large number of such seedlings. Experiments have shown that their survival and subsequent healthy development can be secured if tended properly and in time. Therefore, at least a year before any evergreen forest is due for felling, it should be carefully examined and, if such seedlings are found, the undergrowth up to a height of 20 feet from the ground level should be cleared as soon as possible. This operation is called "Brushwood cutting."

2. Evergreen areas without seedlings of *gurjan, lambapathi, taungpeing,* etc., are rare.

However, if such areas are found, the treatment should be modified to the extent that whenever *gurjan* seeds profusely and the seedlings appear on the ground—this invariably happens every second or third year—the undergrowth up to 15 or 20 feet from the ground should be cleared at once. These seedlings then establish themselves and although they do not develop to any appreciable extent, can hold on for two or three or more years; thus, with such periodical treatment, their life can be prolonged until that area is due for regeneration fellings.

3. *Gurjan* is one of our major timber species. It does not seed every year, and the ripe seeds fall in April and May. The rainfall starts, usually late in May and occasionally early in May. The seeds lose their vitality rapidly and, unless there is a happy coincidence of seedfall with rainfall, germination rarely occurs and, unless they are treated at once, the seedlings die out before they can send up a third leaf. Artificial methods have not been successful so far. It is therefore, of the utmost importance that advantage should be taken of profuse seed years, and the areas due for regeneration should be submitted to brushwood cuttings. (This actually happened in 1941 and about 600 acres due for regeneration in subsequent years were thus treated with great success.)

4. If such favourable circumstances do not present themselves and, if the area is devoid of sufficient advance growth, the area should be left alone, after clearing brushwood up to a height of 10 or 15 feet. This is hardly likely as observations have shown that *gurjan* seeds profusely every second or third year and also, so far there has been no unsurmountable obstacle in regenerating wet evergreen forests. Indeed except for *gurjan*, for reasons stated above, the regeneration of wet evergreen forests is as easy as the deciduous and semi-deciduous forests.

5. Until recently it was the belief that seedlings of evergreen species die out if suddenly exposed. It is now found that it is not so and in fact, like *padauk,* they appreciate heavy opening and again, like *padauk,* they like a little competition with other species or erect growing weeds. Therefore, along with general regeneration fellings, provided the seedlings are at least a season old, all tree growth should be girdled. Felling unwanted trees in evergreen areas is definitely harmful as climbers soon spread over them and form a thick and leafy umbrella over the seedlings and kill them. They should, therefore, be girdled.

6. No burning should be done.

TENDING THE YOUNG CROP— FIRST YEAR

1. Weeding should be done in July or August. In the first weeding it is advisable that all weeds, especially the seedlings of climbers and creepers, should be uprooted. A little competition with erect weeds is healthy. Constant and clean weedings are, therefore, unnecessary. However, climbers and creepers should be watched and uprooted in December to January. As the first weeding proceeds, or immediately after the first weeding, final fellings of any trees still left standing should be carried out. Only saleable trees should be felled and the rest girdled. The logs should be dragged out of the area as soon as possible. Keep the elephants away from the regenerated areas as otherwise they destroy *'lambapathi (Sideroxylon longepetiolatum), bakota (Endospermum malaccense)* and *taungpeing* (*Artocarpus chaplasha*).

TENDING THE YOUNG CROP— SECOND YEAR

Lambapathi and *bakota* are fast growers and reach five or six feet at the end of the first year. Others, especially *gurjan,* are fairly slow growers and reach about three feet in height. Weeding and climber-cutting are therefore, necessary in the second year in July and August, and again in December-January. Any tree girdled and not dead must be regirdled.

TENDING THE YOUNG CROP—THIRD AND FOURTH YEAR

Climbers, and also any useless species interfering with the main species, should be cut in August-September, or according to the requirements of the crop.

FIRST THINNING AND CLEANING

The 1934 area in Kyitaung was thinned at the age of six. However, further experiments and observations are necessary before this operation can be standardized in any way.

(To be continued)

EXTRACTS

THE USE OF HYDROPONICS IN THE PRACTICE OF FORESTRY

BY R. V. OLSON†

Growing forest seedlings in nurseries entails a great deal of labor and time. The use of "hydroponics," or "soilless cultures," promises to accelerate the production of mature planting stock and to improve its quality. In this method, the seedlings are grown from seed in nutrient solutions in early spring and after several weeks are transplanted to nursery beds for further development and hardening. This paper reports the results of an investigation of various aspects of hydroponics in forestry practice.

The first successful attempt to grow forest seedlings in nutrient solutions was made in 1881 by Nobbe (12). Since then this method has been extensively used in horticultural investigations (3, 14, 20), but similar studies dealing with forest trees are of relatively recent date.

Herbert (7) carried on an extensive study of the growth of black spruce seedlings in solutions of widely varied nutrient contents. Aldrich-Blake (2) applied the method of sand cultures in his investigations of ammonia requirements of Corsican pine. Green ash seedlings were grown in solutions of different osmotic pressures by Steinbauer (17). Howell (9) studied the effect of nutrient solutions on the root development of ponderosa pine seedlings. A better growth of rhododendron in sand cultures than in soil was demonstrated by Spencer and Shive (16) with high survival and good growth after transplanting to the field. Dunlop (4) compared the development of spruce and arborvitæ in sand cultures and in soil.

The problem of white pine nutrition was investigated by Mitchell (11), who employed sand cultures with varying amounts of nitrogen, phosphorus, potassium, and calcium. Pessin (13) reported several deficiency symptoms of long-leaf pine based on his work with solutions lacking essential elements. Addoms (1) maintained loblolly pine in sand cultures with continually renewed solutions for a period of 29 months. Rosendahl (15) grew red pine seedlings in mycorrhizæ-inoculated sand cultures for six months, and observed high survival and considerable increases in their dry weights during the two years following transplanting to Carrington silt loam prairie soil in southern Wisconsin.

The general significance of nutrient solutions, heretofore considered a medium for purely theoretical studies of plant behaviour, was radically changed by Gericke (6) who introduced soilless cultures for the commercial growth of crops and also proposed the word "hydroponics" for this type of culture. In recent years the principles of hydroponics

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† Chemis. Hercules Powder Company. The author expresses his appreciation to Professor S. A. Wilde, under whose general direction the work was done. A debt of gratitude is owed to Mr. Wm. H. Brener, superintendent of the Griffith State Forest Nursery, Wisconsin, for his wholehearted co-operation in various phases of the work.

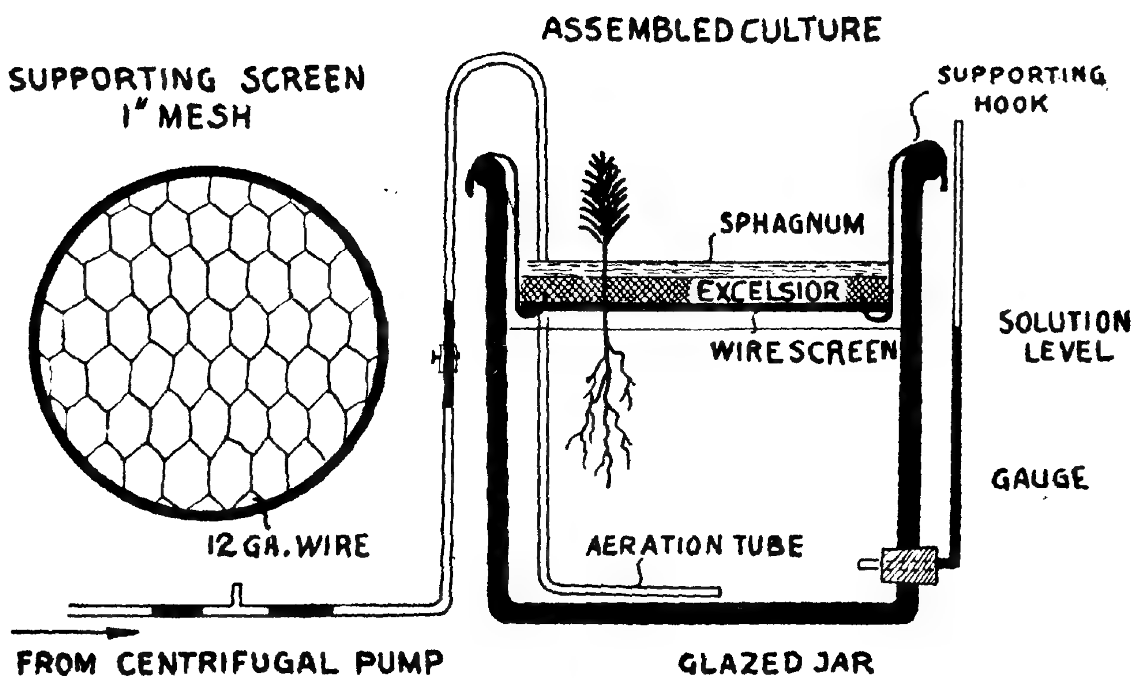

Fig. 1.—Schematic drawing of a set-up for growing forest seedlings in nutrient solutions. A similar arrangement may be applicable for hydroponic production of nursery stock on a large scale.

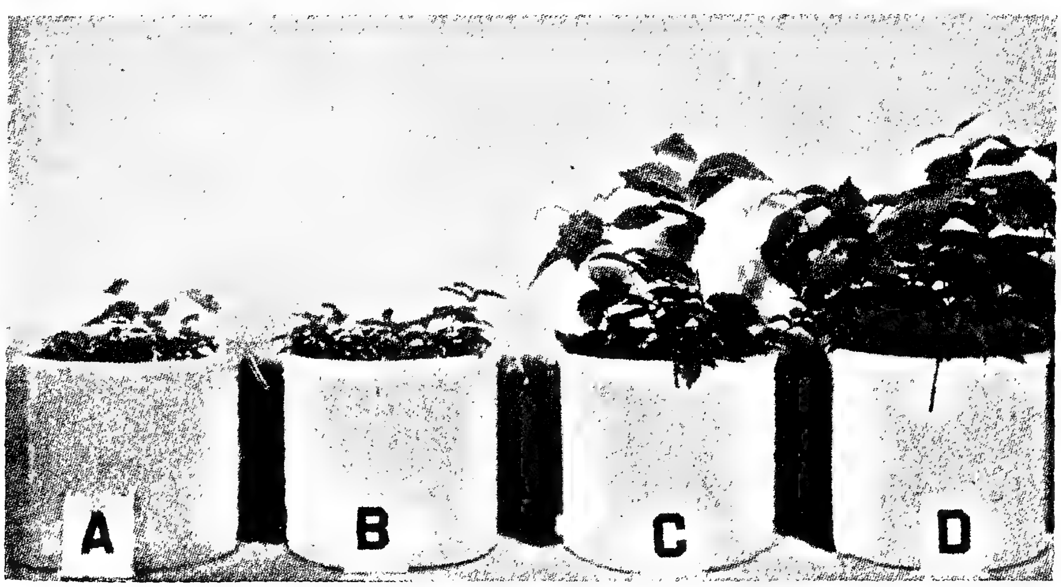

Fig. 2.—Ten-week-old seedlings of American elm grown in a fertilized nursery soil (A and B) and in nutrient solutions of varying concentrations (C and D).

have been discussed and developed by a number of writers (5, 8, 19, 24). Mirov (personal communication) made the first attempts in California to adapt hydroponics to forest nursery practice.

METHOD OF STUDY

In the present study the seedlings of both coniferous and deciduous species were grown on circular screens suspended $\frac{1}{4}$ to $\frac{3}{8}$ inch above the level of nutrient solutions contained in glazed clay jars of 1 or 2 gallons capacity. The screens were made by covering circular frames of 12-gauge wire with 1-inch-mesh screen. The screens and supporting hooks were coated with asphalt paint. A glass tube was inserted in the drainage hole of each jar to indicate the level of the liquid. The jars were aerated daily for two hours by bubbling air through glass tubes connected with a centrifugal air pump (*Fig.* 1, *plate* 16).

Pine needles, leaf mold, glass wool, excelsior, and sphagnum moss were used for seedbeds. These were watered until germination was completed, at which time the solution was added to the jars. The levels of the solutions were adjusted to permit a direct contact between solutions and the young roots.

Nutrient solutions were prepared from reagent grade chemicals and distilled water. They were replaced at intervals of from 10 to 14 days. Iron citrate was added frequently. The volumes of the solutions were kept constant by additions of distilled water.

Sphagnum moss proved to be the most desirable seedbed, because of its high water-holding capacity and fibrous nature. However, first seedings of pine on the moss resulted in severe outbreaks of damping-off, which was stimulated by an excess of moisture in the seedbed resulting from a direct contact of some strands of moss and the solution. This situation was remedied by placing a $\frac{1}{4}$ into $\frac{1}{2}$ inch layer of excelsior, washed in distilled water, upon the supporting screen, with a thin layer of clean sphagnum moss, similarly washed, on the excelsior. Seeds were then sown and covered by another thin layer of the moss, and the entire seedbed was moistened and packed. This method practically eliminated the losses due to damping-off and in some instances led to an appreciable increase in the dry weight of seedlings.

Composition of the Nutrient Solutions.—The initial composition of the nutrient solution was established by reference to the contents and the ratio of nutrients occurring in forest soils as reported by Wilde (21) and Wilde and Patzer (22). These data were supplemented by information available in many reports, particularly those by Tottingham (18) and Hoagland and Arnon (8).

The study of the influence of nutrients upon the growth of seedlings was largely limited to the three essential elements, nitrogen, phosphorus and potassium. Two characteristic species—American elm and red pine—were used as indicators, and on the basis of tests with these, the final composition of the nutrient solution was adjusted as follows:

Ammonium phosphate, $NH_4H_2PO_4$	..	0.400
Potassium nitrate, KNO_3	..	0.400
Calcium nitrate, $Ca(NO_3)_2 \cdot 4H_2O$	..	0.450
Magnesium sulphate, $MgSO_4 \cdot 7H_2O$	..	0.350
Ammonium nitrate, NH_4NO_3	..	0.300
Ferric citrate, $FeC_6H_5O_7, 3H_2O$	..	0.030
Boric Acid, H_3BO_3	..	0.003
Manganese chloride, $MnCl_2.4H_2O$	..	0.002
Zinc sulphate, $ZnSO_4.7H_2O$	..	0.0002
Copper sulphate, $CuSO_4.5H_2O$	..	0.0001
Molybdic acid, $H_2MoO_4 \cdot H_2O$	..	0.0001

This solution contains approximately 260 p.p.m. of potassium, 75 p.p.m. of calcium and 35 p.p.m. of magnesium. With minor variations, it was successfully used for American elm, hard maple, white ash, catalpa and yellow birch as well as for Norway and white spruce. The concentration of this solution, however, was reduced 40 per cent. for growing red pine, jack pine and other species of low-nutrient demands.

It cannot be overemphasized that the most suitable composition of the solution used in hydroponics is subejct to considerable variation, depending upon the intensity of light

(19), temperature, species grown and the desired morphology of the planting stock. Constant observation of the development of the stock, supplemented by periodic analyses of solution, is essential for the satisfactory management of nursery hydro-cultures.

Changes in the Solution caused by the Growth of Seedlings.—Periodic analyses of the nutrient solutions were made on 60 ml. aliquots which were replaced by equal volumes of the original solution. Table 1 presents the changes in a solution, three litres of which nourished 24 American-elm seedlings for 29 days from the time of their germination. These results suggest that nutrient solutions, in which young hardwood seedlings are growing at the rate of eight seedlings per litre of solution, should be replaced or adjusted at intervals not exceeding two weeks. Solutions in which older seedlings are growing should be adjusted more frequently. Should a greater volume of solution be used, less frequent changes would be necessary.

Table 1 also summarizes the changes in a solution three litres of which supported 22 red-pine seedlings five weeks old at the beginning of observation. The rapid exhaustion of some nutrients, particularly magnesium, required in this case a readjustment of the solution at intervals of less than two weeks.

Morphological Features of Stock.—The possibility of controlling closely the morphological development of seedlings through the adjustment of the nutrient ratio is one of the great advantages of hydroponics. While water cultures permit raising seedlings in greater densities than in nursery beds, excessively heavy seedings lead to partial stagnation of stock and a generally less favourable toproot ratio. Frequent æration of tanks tends to decrease the toproot ratio and thus to improve the quality of the stock. The beneficial effect of æration, however, becomes appreciable only if solutions are kept in tanks for a long time.

TABLE 1.—CHANGES IN COMPOSITION OF NUTRIENT SOLUTION CAUSED BY THE GROWTH OF AMERICAN ELM AND RED PINE SEEDLINGS

Days of growth	Reaction pH	Composition of nutrient solution[1] Nitrate nitrogen	Ammonia* nitrogen	Phosphorus	Potassium	Calcium	Magnesium
			American elm				
0	5.0	132	194	48	163	104	49
13	5.0	100	154	33	135	95	48
20	4.5	88	135	31	153	94	42
29	4.3	84	133	29	132	93	40
			Red pine				
0	5.0	93	60	107	147	100	34
6	4.0	80	48	93	136	85	22
12	3.6	61	45	84	125	76	15
18	3.6	59	40	79	118	71	11
24	3.5	56	34	76	109	66	8

[1]All figures are in parts per million,

An important role in the development of desirable nursery stock grown in water cultures must be attributed to periodic pruning of root systems. Unpruned seedlings are seldom suitable for transplanting into the nursery beds or in the field because of their excessively long and unbranched roots. Pruning, however, is easily accomplished in hydroponics by lifting the entire seedbed frame and shearing off the roots with large scissors; the recovery and new growth of pruned roots proceeds in solutions with remarkable rapidity.

The possibility of root-rot infection of pruned stock has been suggested by Dr. Carl Hartley, but thus far such infection has not been observed.

A problem of prime importance that arose in connection with silvicultural hydroponics was the lack of mycorrhizæ on solution-grown

seedlings. This was satisfactorily solved by Wilde and Rosendahl (unpublished manuscript), who succeeded in inoculating solution-raised seedlings by both the pure culture methods and by transplanting into mycorrhizæ-abundant nursery soils.

Growth of Hydroponic Stock

Table 2 shows the dry weights produced by American elm and red pine seedlings grown simultaneously for 10 weeks in fertilized nursery soil and in nutrient solution. The great weight of the seedlings grown in nutrient solution is striking, and ran as high as 410 per cent. with the tops of American elm. This difference is illustrated in *Figure 2, plate 16.*

Table 3 gives the results of tissue analyses of the same seedlings grown in both media. It is significant that the seedlings raised in solution have a higher content of nitrogen, phosphorus, and potassium and also a better balanced ratio of these elements than the seedlings raised in nursery soil. Evidence obtained in recent investigations suggests that the abundant content of nutrients provided by solutions will contribute to the survival and future growth of seedlings in the field (10, 23).

Because of limited time, only general information was obtained concerning the survival and growth of hydroponic transplants. In the fall of 1941, 8-week-old seedlings of American elm and 10-week-old seedlings of red pine were transplanted to Miami silt loam soil near Madison, Wisconsin. In the spring some losses were observed due to heaving and winter injury, but the total survival approached 80 per cent. During the following summer no further losses were observed, and the seedlings continued to grow vigorously.

Table 2.—Comparison of Dry Weights of Red Pine and American Elm Seedlings Grown in Nursery Soil and in Nutrient Solutions

Growth medium	Dry weight of aver. seedling, milligrams — Red pine — Tops	Roots	Total	— American elm — Top	Roots	Total
Nursery soil	50	15	65	51	24	75
Nutrient solution	108	27	135	260	51	311

Table 3.—Comparison of Chemical Composition of Red Pine and American Elm Seedlings Grown in Nursery Soil and in Nutrient Solutions

Growth medium	Contents of essential elements, per cent — Red pine — N	P	K	— American elm — N	P	K
Nursery soil	1·88	0.13	0.42	2.08	0·16	0.96
Nutrient solution	2·70	.53	0.83	3.39	0.50	1.41

In the spring of 1942, a tank culture for the production of several thousand seedlings of different species was established in the greenhouse of the Griffith State Nursery, Wisconsin. In the middle of June the seedlings of American elm, yellow birch, catalpa, white spruce, red pine, and a number of shrubs used as a source of game food were transplanted into nursery beds. The growth of these transplants exceeded all expectations.

The solution-grown transplants in some instances weighed 400 to 500 per cent more than ordinary nursery stock of the same age, and showed superior development of root systems.

The results of the study suggest that the use of hydroponics may accelerate the production of planting stock and improve its quality. The growing of seedlings in nutrient solutions in the early spring and their subsequent transplanting in the early summer into nursery beds for further development and hardening appears to be especially promising with some species.

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THE FOREST AS A FACTORY

BY PROF. E. P. STEBBING,

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In a memorandum written for a Government conference last summer, I made the statement that the forest is a "factory" just as much as a factory turning out tanks or aeroplanes. The statement appeared to create some surprise. Let us consider how it may be justified though, with the exception of India, inadequately recognized in that great organization—the British Empire and Commonwealth of Nations.

We will first look at India: in spite of the fact that many heads of the other forest services hold that Indian forestry conditions, with all their great range of climate, soils, species, plains and mountains, are not applicable to conditions outside that country. During the War of 1914—18, India very soon found herself, owing to deficient shipping, deprived of many imported goods and left to her own resources. The forests, with an adequate forest staff for the purpose, were soon called upon to supply large military and civil requirements; and the young Forest Research Institute played a remarkable part in assisting in this matter. This is familiar history. Once again, in the present war, the same position has had to be faced in India on an even larger scale. Once again her forests, having been under a conservative management for just eighty years, under an adequate forest staff and assisted by one of the biggest and best equipped forest research institutes in the world, have proved adequate to the call upon their resources.

An examination of some of the war publications from the latter, *Records, Bulletins* and *Leaflets*, prove, if proof be necessary, that the forest is merely a giant factory which in combination with the work of the research officer (for example, in an aircraft factory

where the combination is now fully recognized) can face new demands, provided a sufficiency of labour is available. Examples of this work have already been given in these columns (*Nature*, 153, 201; 1944). They furnish evidence of how research, with the forest to provide necessary raw materials, was able to come to the assistance of the Figthing Services, as well as civilians, when imports of many kinds ceased. The research part of the 'Factory' solved the problem of finding a substitute article for the one which could no longer be imported; the 'forest factory,' according to location of supplies, well known to an organized department, provides the raw material; and the third 'factory' in the business, the only one recognized by so many, makes up the article. But the third would have been non-existent had not the second existed. A prerequisite to all this organization and its successful issue, without over-exploiting or devastating the national forests, the ownership of which is—or should be—vested in the peoples of the country, depends upon an adequate forest staff, and a working knowledge by the latter of the whole of the forest areas of the country concerned.

A study of recent annual reports of some of the Colonial Forest Services is by no means so reassuring. In many instances the 'forest factory' is being heavily exploited for war requirements without the requisite safeguards, which are adequate knowledge of the contents of the forests and a sufficient staff to superintend excessive fellings. The capital of the country, which belongs to the people of the country, is consequently being dissipated.

Reference has already been made to the heavy unsupervised fellings being made in the United States in the Douglas fir and companion species, West Coast hemlock, Sitka spruce and Western cedar forests to supply war-time demands (*Nature*, 152, 651; 1943). Another instance of the same is quoted from Alaska. In the rain-drenched Tongass National Forest of the unknown south-eastern Alaskan panhandle, a forest larger than the State of Western Virginia, is situated what is said to be the world's last great reserve of Sitka spruce, the pre-eminent aircraft timber. Many thousands of these great trees, with a height of 200 feet, 80 feet clean bole to first branch and 6 feet diameter at breast height, were felled in 1943; the War Production Board, with much of the best forests in Oregon, Washington and British Columbia cut over, having arranged to open out the Alaskan wilderness.

Many examples from recent publications could be culled to show the position the forest occupies in a country in periods of stress when that country can no longer rely on imports of certain staple commodities. The forest at once forms one side of the 'factory.' Without the forest several types of factory, including one of the latest, the plywood factory, would not exist. No commercial man would consider it possible to run a factory in peace- or war-time without the necessary trained supervisory staff to ensure efficient output and a continuity in that output. Any attempts to reduce such staff as redundant would be met with suspicion and a *non possumus*. Further, it would be equally recognized that to ensure that a continuity of output is maintained supply of the necessary raw materials must be available in the amounts already calculated.

How does the 'forest factory' come off in this respect? A study of even the few instances given above serves to show that the position of the forest as regards the supplies it affords to the factory dependent upon it and its relation to that factory is rarely understood. The idea appears to be still held in some quarters that the forest can go on supplying indefinitely the products required from it with a very inadequate supervisory staff, if indeed any such staff is present: whereas the truth is that this type of utilization of the forests results (far quicker in war-time) in its gradual exhaustion, and with the latter the collapse of industries and their man-power dependent upon them. For a forest is a delicate organism and easily ruined by ill-judged fellings.

How is the forest to be maintained and safeguarded? To rehabilitate a forest which has been wastefully and ignorantly exploited,

in the absence of expert supervision controlling the work, will take a century or more, if timber is the desideratum. How is a continuity of material from the forest and the consequent continuity of the factories dependent upon it to be maintained? A trained and expert staff is necessary for the factory. Equally so for the forests. If, as so often in the past in the British Empire, such a staff is only brought in in inadequate numbers after the forests in question have been partially or totally ruined by over-exploitation in one or other of its many possible forms, a long and uphill struggle has to be faced and considerable expense. Trees are not agricultural crops; they require considerable periods of time to produce what is required; even if only of small size such as pitwood, fuel plantations and so forth. In the absence of a trained staff, an ignorantly exploited forest, if of conifers, may result in the total disappearance of the forest from the area; if of hardwoods, the same may take place, the time elapsing being much longer. But the final results in many cases may be the disappearance of the population which lived in that neighbourhood. History has already witnessed whole populations moving to more salubrious parts or gradually dying out owing to the destruction of the neighbouring forests, with the consequent impoverishment of the soils and the diminution of the water supplies. In former times the aftermath of forest destruction and impoverishment of the soils only made its appearance over long periods of time: not so nowadays. With increased populations, with increased methods of rapidly exploiting rich forest areas, and greatly improved methods of transport, a forest can be destroyed, so far as its future usefulness to man is concerned, in a comparatively short time, even in days of peace.

In times of war and stress, an accessible forest and, with expense no object, previously so-termed inaccessible forests, unless under the watchful supervision of their only possible guardians, the trained forest officers, fully acquainted with their regions and in sufficient numbers to enforce correct methods of working, can be exploited and ruined in a very short space, as in the American examples quoted above.

In connection with the improvident and ignorant utilization of the forest by the populations inhabiting the regions in the past, alluded to above, the present-day consideration being paid to soil conservation schemes both in parts of the Old World and the New merits mention here. Perhaps the most modern examples of the ignorant treatment of forest and agricultural soils is to be seen in the popularly termed 'desert bowls' in the United States and parts of Canada; and also in Australia. As a result, thousands of farmer families have had to emigrate, the once fertile regions having been reduced to desert conditions. But the world has had for long many older examples, and over wider regions, of this misuse of the land and its vegetation. The British Empire affords many illustrations, of which large stretches in Africa offer examples. This position is at length being considered from the only possible practical aspect, to wit, soil conservation schemes —schemes the primary objective of which is to stay the further desiccation and spread of desert conditions, coupled as they invariably have been with lessening rainfall and water supplies and the migration of the peoples affected.

Excellent examples of the modern changed attitude to this question are afforded by the Governments of the Sudan and Kenya. These Governments have apparently realized that soil conservation must be approached by bold schemes, not by small experiments of merely local interest having little reference to the broad requirements of the country affected as a whole. In the Sudan, an active soil conservation policy is under consideration. The sitting committee has adopted, it is understood, a comprehensive programme for which a considerable sum has been earmarked, and which, if and when put into force, will immediately provide employment for a portion of the demobilized native troops. In Kenya, projects of development are foreshadowed. The principal scheme is one for soil conservation, for which, it is said, a sum of £940,185 has been allocated.

The forester will indubitably take an active part in this work; for trained supervision will be essential if money is not to be wasted. One of the forester's jobs will be an endeavour to replace blocks of forest on the ruined and impoverished soils, the primary purpose of which will admittedly be a protective one while assisting in the restoration of the soil water supplies. But as the secondary objective, these forests will in time serve as the factory from which produce will be available to an increasing population returning to a formerly destroyed but now rejuvenated area.

These are neither visions nor dreams. But to understand the job and its possibilities, it will be at least necessary to allow those whose business in life it has been to study, consider, and interpret the factors concerned, to prescribe the possible practical remedial measures to be put into force and, in addition, to the necessary funds, to ensure that a trained staff in the necessary numbers is forthcoming.

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LOPPING IN THE KUMAUN HIMALAYA OF UNITED PROVINCES

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Summary.—The article comprises a note on the history of lopping in the forests of Kumaun (mainly of oaks) and the influence of varying governmental policies towards lopping. It contains an appreciation of the present position; the serious results of unrestricted lopping and the dangers inherent in the practice, unless carefully limited. The importance of **kharaks** (steadings for cattle inside forests) as centres of lopping damage is stressed, and changes in the present policy are suggested.

In order to understand conditions as they are to-day, it is necessary to consider the history of these forests from the initiation of the policy of conservation of forests in Kumaun.

Also, it is necessary to consider different groups of species separately, as the conditions and rules are different for different species.

I—BRIEF HISTORY

The first appreciation of the value of hill forests seems to have been in the year 1826, when the first attempts at reservation were made in the submontane areas of the hill *Pattis*, later incorporated in the Western Circle. (Nothing further about these parts of the hill *Pattis* will be given in this note, as the information is not available here.)

In the hills proper, the preliminary steps for creating a forest estate were taken in the year 1879, when Kaligadh and Jagdeo blocks of Ranikhet Reserve were notified as "Rights-free Reserves." This was followed by a general order of 1893 declaring all unmeasured lands to be notified as protected forest.

This was immediately followed by full reservation of certain areas, during the period 1893 to 1898, after admitting certain rights. These forests are now known as the "Old Reserves" and "Plantations."

Such forests as remained protected but not reserved were, in 1903, classified into "Closed Civil" (directly under the Deputy Commissioner) and "Open Civil" (under the control of *patwaris* and *malguzars*). This management proved unsatisfactory, and it was decided to reserve the "Closed Civil" and bring it under Forest Department control. A regular Forest Settlement was therefore carried out between 1911 and 1917 and the "Closed Civil" thus reserved became the present "New Reserve," after admitting certain rights, rather more liberal than in the "Old Reserves."

The "Open Civil" (now known simply as civil forest), though still nominally protected forest, remained under the nominal control of the Deputy Commissioner. In actual fact, control was almost entirely lacking, except that a notification of 1915 declared the following trees to be reserved throughout Kumaun:

1.—*Deodar*.

2—Cypress.

3.—Walnut.

4—*Toon*.

5—All trees growing within 50 feet of the centre of any district board or government road.

(To this was later added Boxwood.)

No sooner was the reservation and demarcation of boundaries complete, than agitation to disforest a great deal of reserved forest, set back boundary pillars, relax the rules and increase the rights commenced.

The agitation was natural and widespread, but it gained terrific impetus as a result

of the rather high-handed attitude of forest subordinates at that time; but more particularly as a result of political agitation which fanned the flames: the politicians using this genuine grievance to gain political kudos, regardless of the better interests of the population.

This agitation reached a climax in 1921, when a Forest Grievance Committee for Kumaun was set up to inquire into the matter. Even before this, however, a great area of reserved forest had to be disforested for purposes of cultivation. The Grievance Committee concluded its work by the end of 1921, and submitted its recommendations to Government, which were accepted and incorporated in a Government Order No. 895/XIV-285-1924, issued in 1925.

Under this order, apart from greatly relaxing the rules and making enormous additions to rights and concessions recognised at the time of Settlement in "New Reserves" (the "Old Reserves" were fortunately not within the scope of the enquiry of this committee), the "New Reserves" were divided into two classes:

Class I Reserves.—Which were defined as "Forests which, although of little or no commercial value, are of importance because they help to maintain the water supply in main rivers and catchment areas of the Himalayas. Instances of such forests are the Gagar Range of hills in Naini Tal, the oak forest of Bhatkot and Dudatoli and the northern oak forests of Almora and Garhwal."

Class II Reserves.—Which were defined as "All forests now stocked with *chir, sal, deodar,* cypress, *kail,* spruce or silver fir, which are commercially exploitable, or likely to become so in the near future, together with fuel and grass reserves and *deodar banis.*"

Class I forests were taken away from Forest Department control altogether and handed over to the nominal control of the Deputy Commissioner, after relaxing almost all restrictions on rights. These comprised about half of the original reserved forest area.

Class II forests remained under the Forest Department; but the restrictions on rights here, too, were relaxed to the limit.

This state of affairs remained practically unchanged until 1939, when a further "Investigation of Villagers' Rights in Kumaun Circle" was undertaken by the Kumaun Forest Committee at the instance of the popular elected government then in power—this was primarily an attempt to grant still further rights and concessions to the local people at the expense of the remaining forest area under the control of the Forest Department; but it gave the Department a providential opportunity to publicise the catastrophic effects of the G.O. No. 895 of 1925, which had already resulted in vast tracts of oak forest being brought to the very verge of total extinction on important water-catchment areas. So terrible was the destruction and havoc and so clear to even the most unseeing eyes that Government, when considering the proposals incorporated in the 1939 report, issued a G.O. No. 145 AF/VIIX-308-1936 in March, 1941, which introduced restrictive measures bringing the position back in many respects (particularly as regards lopping) to the position before the issue of G.O. No. 895, except that the two Classes I and II Reserves remained as before.

Note—The Government's reply to the 1939 Investigation Report was actually issued later, in September, 1941—G.O. No. 605/AF, and this in no way greatly changed the position.

Since 1939, taking advantage of the awakened interest of the Deputy Commissioners in their forest wealth, a general trend towards closer supervision of Class I forests and introduction of extensive closures in the most seriously denuded Class I and Class II forests has been the order of the day, offset to some extent by gratuitous permission by the Forest Department to certain villagers to practise hand-stripping of broad-leaved species on a definite controlled scheme in areas of "Old Reserves" which are strictly closed to lopping under the rules: combined with free grants of fuel from Class II forests near villages.

II—GROUPS OF SPECIES TO BE CONSIDERED SEPARATELY

(*a*) *Deodar*, cypress, walnut, *toon* and boxwood and all species of trees within 50 feet of roads maintained by District Boards or Government have, from the very beginning and up to the present date, always been fully reserved, and felling or lopping of these trees has always been prohibited everywhere. These have always been known as "Royal Trees" and they can be and are omitted from all further consideration.

(*b*) *Chir, sal, kail*, spruce, silver-fir and bamboo. Since the formation of Class I and Class II forests, these trees have remained closed to lopping in Class II, but have been open to lopping in Class I, to the extent that lopping of any species has been allowed.

(*c*) *Oak*: This species represents the main fodder-tree species in the hills and this is the species mostly concerned in dealing with lopping problems.

(*d*) *Kokat*: For all practical purposes it may be said that the felling and lopping of these species has always been permitted everywhere except in the rights-free "Old Reserves." It may be left out of all further consideration as *kokat* never has been and probably never will be protected from lopping in the hills, except as a special erosion or fodder-control measure in limited and specified areas.

III—RULES GOVERNING LOPPING AT VARIOUS STAGES IN THE HISTORY OF THESE RESERVED FORESTS

(*i*) *Rights-free "Old Reserves."*—No lopping has ever been allowed, and little illicit lopping occurs or has occurred, except in parts of Naini Tal Division around Naini Tal, where a great deal of illicit lopping occurs in spite of all efforts to stop it.

(*ii*) *"Old Reserves."*—No lopping has ever been allowed but, in 1939, as an experiment, stripping of oak leaves *by hand* in specified areas (some opened annually for a set period, others opened every other year for set period) has been permitted in certain "Old Reserves." The scheme is fairly successful; but is extensively abused in that lopping of bigger branches, by means of axe and sickle, is done. It now appears advisable to restrict this concession to areas where oak is not required for any purpose and to enforce full closure to lopping again in the genuine oak areas. So far, *this abuse of lopping in areas* where hand-stripping is permitted has not reached serious proportions, except in parts of Naini Tal Division, and there is little lopping in the areas closed to stripping.

(*iii*) *"New Reserves."*—These are the areas really affected by lopping. From date of formation up to 1921, lopping of all species except *kokat* was practically forbidden in Almora and Naini Tal, and was allowed under cumbersome rules in North Garhwal. Some relaxation occurred unofficially from 1921 until 1925 in which year the iniquitous G.O. No. 895 was passed, splitting these reserves into Class I and Class II and ensuring the rapid destruction of the oak everywhere by permitting lopping and felling not only by right-holders but by all *bona fide* residents of Kumaun. This led to a competitive orgy of destruction, as can well be imagined.

The actual rules as regards lopping were:

Class I.—"All *bona fide* residents of Kumaun are permitted to—fell and lop trees—save as provided below:

(1) No 'Royal trees' may be felled, lopped or damaged without written permission of the Deputy Commissioner."

Class II.—"In any of these forests, except regeneration areas, fuel and fodder reserves, plantations and *deodar banis*, all *bona fide* residents of Kumaun are granted concession to lop without restriction any tree except:

Royal trees, *Chir*, Spruce, *Sal*, Silver Fir, *Kail* and Bamboo."

This was the position up to 1941, so far as the rules are concerned. The devastation that occurred in this period has to be seen to be believed, and was in fact worse than it now

appears, since recent closures have prevented many old mature trees from dying outright. But they are so weakened that they will die shortly, and may not seed up their surrounds before they do so. Before going on to the G.O. of 1941, and the swing of the pendulum towards conservation, it is necessary to consider how the availment of the lopping concessions of G.O. No. 895 came to cause such a holocaust of devastation in so short a time; and also to see how the realisation of this widespread destruction of oak forests caused a revulsion of feeling in the minds of many of those very villagers who had pressed so hard, so short a time before, for the extension of the rights and concessions they now reacted against.

First, then, how did the damage occur so furiously over so great an area, so soon? To understand this, the system of *kharaks* must be understood. Since the reservation of "New Reserves" started, rights to stead cattle in temporary sheds in the rains, inside the forest grazing grounds, were recognised and granted and the owners were also permitted to erect temporary dwellings and to have limited cultivation. These temporary steadings are known as *kharaks*. Up to 1921, cattle were admitted only after enumeration and to the extent that, and to those villagers to whom, rights were recorded at the time of Settlement. Fees were charged for cattle in excess, and buffaloes, sheep and goats, the browsers, were excluded.

There is no doubt that the restrictions imposed on numbers caused much ill feeling, and that these restrictions were probably considerably abused by the subordinate forest staff as a source of illicit gratification. As a result much pressure was brought to bear on the 1921 Committee to remove these restrictions.

These *kharaks* were recognised sites, visited by certain villages annually, and it will readily be appreciated that the grass in the vicinity was all grazed back shortly after the arrival of the cattle each year. The remedy for the shortage of grazing was obvious—lopping; and this is one good reason why nearly all *kharaks* are situated in the oak forests, as well as the fact that the sites of *kharaks* would naturally be in the cooler, higher altitudes, where oak occurs most frequently. As can well be imagined, each of these *kharak* sites became the nucleus of a spreading area of devastation of oak and broadleaved species. The lopping was started by cutting off the ends of the branches, and each lopping cut these branches back more and more, until the main stem (or a heavy branch in the case of old and mature trees) was reached. All leaves are cut off at each fresh lopping so that the tree eventually weakens and dies. The intensity of lopping is of course most intense nearest each *kharak*, with decreasing intensity as the distance increases. The belt of dead trees round each *kharak* widens annually, and the circumference of the lopped area also increases annually.

As has been said above, the right to use these steadings or *kharaks* was, up to 1921, recognised only for certain specified villages, and their right to stead cattle in certain blocks was recorded. But the actual site of each *kharak* was not recorded.

So long as all reserved forests remained under the Forest Department, and the *kharaks* were only used by those villagers whose rights were recorded, the *kharaks* were all known by name, and damage, though fairly serious, remained restricted to the immediate neighbourhood of each *kharak*. The nearest trees were all brought to the verge of death, but the limited utilization of more distant trees allowed them to live and recover, and so brought about a state of balance within a limited area around each *kharak*, except in the case of the most vigorous and expanding village communities; and even here, the imposition of fees on the excess cattle kept the expansion within bounds.

But the G.O. No. 895 removed all restrictions on the number of cattle permitted, and went even further by allowing the *kharaks* to be used throughout Class I and II Reserves not only by villagers whose rights were recorded, but also by all *bona fide* residents of

Kumaun as follows:

"All *bona fide* residents of Kumaun are granted the concession to stead cattle free, without counting or restriction as to numbers or passes in any of the *kharaks* demarcated on the ground by the Forest Department. Temporary cultivation to the maximum of one acre is allowed within the boundaries of each such demarcated *kharak*."

When it was found how little interest and control was taken in the Class I forests, removed from the control of the Forest Department under this same G.O., this at once led to many persons in Class I forests starting up their own separate *kharaks;* and the throwing open of both Class I and II forests to all *bona fide* residents of Kumaun led to an enormous increase in the numbers of cattle, buffaloes and browsers so that even in Class II forests there was a big temptation to villagers to open up new *kharak* sites. This movement was foreseen and very largely limited in Class II forests, as the forest officers immediately started to prepare detailed lists of all existing *kharak* sites, demarcating them with permanent pillars, and marking the sites on the divisional maps. At the same time the necessity for doing this in Class I forests was also brought to the notice of the revenue authorities, and work on these lines is still proceeding, though by no means complete, in Class I forests. But it is known that very many new *kharaks* were started in Class I forests after 1921.

The combined effect of new *kharak* sites being opened, together with the terrific impetus given to lopping as a result of the influx of non-right-holders, resulted in a sudden and enormous increase of the areas reduced to the point of death as a result of lopping—so that it became clear to anyone, who looked at these oak areas even from miles away, that the threat of death of square miles of forest, with the certainty of increasing erosion, floods and all the attendant calamities, long prophesied by the Forest Department, was no mere threat but an immediate and imminent possibility, or rather a probability, if prompt action was not taken to restrict the immediate cause, *viz.*, lopping. It is the direct result of this that extensive and extending closures were started. One of the main difficulties in obtaining sanction to closures in the past—local villagers' opposition taken up and made into a political weapon—was found conspicuously absent—in fact, many local villagers themselves moved the authorities to institute closures when they found that the forest which had long supplied all their needs was being devastated in a competitive orgy of destruction—with the influx of non-right-holders destroying what they had long looked upon as their own forest, allotted to them at the Settlement for meeting their rights.

Of course, this extensive damage did not become apparent immediately either to the villagers or to the Deputy Commissioners. The Forest Department, however, knowing what would happen, kept a vigilant eye on the extension of damage, and as soon as it became apparent, started active propaganda to get the seriousness of the position recognised, and to advise and press on towards any form of conservation that could be got adopted.

In 1931, G.O. No. 441/XIV-366 was passed to regulate the management of *Panchayat* forests in Kumaun. The lopping and felling of oak and *kokat* everywhere, by all *bona fide* residents of Kumaun, and the lopping and felling of *chir* in all forests near villages (except Reserved forest Class II and "Old Reserves" and Plantations), soon awakened the villagers to the realization that unless some form of restriction and closure was adopted, those of them who had good forest near their village would soon have their forest ruined by greedy neighbours with no such forest of their own. This gave a tremendous stimulus to the movement towards creation of *Panchayat* forests from all kinds of forest, Reserved Classes I and II, and "Civil forests."

The G.O. No. 441 of 1931 was passed to give clear powers to *panchayats,* formed in this way, so as to take full advantage of this move towards conservation of forests. As much propaganda as possible was done to

take the fullest possible advantage of this changed outlook, and a Forest Panchayat Officer put in charge of the operation.

As the damage areas rapidly extended in dimensions and severity, propaganda and persuasion soon forced the civil authorities to take note of the serious position in their Reserved Class I forests. By 1939, the collection of detailed information about sites of *kharaks* in Class II forests, tracings of *kharak* sites, demarcation by permanent pillars on the ground and a note of each on the standard maps, had been completed; and the Deputy Commissioners had realised the necessity for similar action in their Class I areas and had passed the necessary orders.

Still further, they had realised the need to close great areas of their Class I forest to lopping, if the forest was not to be completely destroyed. Thus, during the period 1939—41, data was collected as to the extent and situation of all Class I forests which were most dangerously and seriously damaged, and in which closure to lopping and felling was most urgent and essential. Similar data was collected for Class II forests and, as a result, action was taken in the year 1941 to date to close 47,770 acres of Class I and 7,285 acres of Class II to all lopping and felling in West Almora Division alone. Similar action will continue and is going on in the other divisions. In order not to alienate local feelings any more than necessary, several concessions were granted inside the closed area—the most important being to allow *kharaks* in the closed area to be occupied by right-holders' cattle only (not browsers). Forest Guards were appointed by the Deputy Commissioners to enforce the closures. Parallel action was taken in all adjoining and badly damaged Class II forest. It will be obvious that the area of Class I requiring closure must be far greater than in Class II, as the former consists mainly of oak forests, and also was liable to lopping of *chir,* which was not the case in Class II.

As a result of this very general realisation of the serious position, the "Investigation of Villagers' Rights," in 1939, was carried out in an atmosphere of considerable concern for the future of these oak forests: and the fact that the popularly elected Congress Government resigned in that year also enabled the officials to press home the necessity for introducing legislation to put a stop to these evils, which put a premium on destruction of forest wealth by throwing the forest open to all comers, and encouraging a "first-come-first-served" attitude. Naturally a popularly elected government, which had always obtained political kudos by reducing restrictions on the availability of forest produce, could not be expected to relish risking the odium of reversing their policy and passing legislation to reimpose restrictions that they themselves had relaxed or removed. I have little doubt, however, that the more intelligent of the elected politicians really recognised the need for closures. Their resignation certainly made it more easy to convince the residual government of the seriousness of the position and the need for immediate action and in 1941 they issued G.O. No. 145 AF/XIV-308-1936. Under this G.O. the rules for lopping were tightened up, reserving this as a limited right, and laying down limits as follows:

Class I:—

(6)—All *bona fide* residents of Kumaun are permitted to graze cattle without limit or restrictions, fell and lop trees, cut grass and exercise all other rights of user in Class I Reserves save as provided below:

(*i*) No tree of the species *deodar,* cypress, *tun,* walnut or boxwood may be felled, lopped or otherwise damaged without the previous permission in writing of the Deputy Commissioner. The concession to fell and lop trees of all other species is restricted to:

- (*a*) Right-holders in that forest where their rights were recorded at the forest settlement, and
- (*b*) Residents of villages within whose *salassi* boundary the forest lies: and provided always that no tree may be lopped within 6 feet from its top.

* * *

(*vi*) *Kharaks, i.e.,* steadings for cattle in the forests are permitted at places defined and within the areas marked on the ground. No

limitation is placed on the number of cattle allowed at a steading. Temporary cultivation up to a maximum limit of one acre is allowed within a *kharak*. Such *kharaks* cannot, however, be used when situated in any area closed to grazing or lopping under Rule 9 (*i.e.*, seriously damaged areas closed for the purposes of re-afforestation or recuperation).

* * *

Class II: —

(10) *Grazing*—All *bona fide* residents of Kumaun are granted the concession to graze cattle free, without counting or restriction as to number or passes, in any of these forests outside regeneration areas, fodder reserves and plantations.

(11) *Kharaks*—All *bona fide* residents of Kumaun are granted the concession to stead cattle free, without counting or restriction as to number or passes, in any of the *kharaks* demarcated on the ground by the Forest Department. Temporary cultivation up to a maximum of one acre is allowed within the boundaries of such demarcated *kharaks*. Such *kharaks* cannot, however, be used when situated in any area, closed to grazing or lopping under Rules 20 or 21 (*i.e.*, areas closed for the purposes of fodder reserve, regeneration or re-afforestation).

(12) *Lopping*—Except that lopping is prohibited in regeneration areas, fuel and fodder reserves, plantations and *deodar banis*, and provided always that no tree may be lopped within 6 feet from its top, the concession to lop in these forests all species other than those mentioned below is granted to:

(*a*) Right-holders in that forest where their rights were recorded at the forest Settlement, and (*b*) residents of villages within whose *salassi* boundary the forest lies:

Species that may not be lopped:

Deodar	.. *Cedrus libani*, var. *deodara*.
Cypress (*sura*)	.. *Cupressus torulosa*.
Tun	.. *Cedrela toona*.
Walnut (*akhrot*)	.. *Juglans regia*
Chir	.. *Pinus longifolia*.
Sal	.. *Shorea robusta*.
Kail	.. *Pinus excelsa*.
Spruce (*rai*)	.. *Picea morinda*.
Silver Fir (*rahga*)	.. *Abies pindrow* and *webbiana*.
Bamboo	.. *Dendrocalamus strictus*.

IV—COMPLIANCE WITH THE EXISTING RULES IN RESERVED FORESTS

A certain amount of lopping still goes on around those *kharaks* situated in areas declared to be fuel and fodder reserves, but very much less than would appear probable. The closure of the *kharak* as laid down in the rules for *kharaks* quoted above (in all areas declared as fuel and fodder reserves) would indeed be a severe hardship on the right-holding villagers. For this reason a special rider has been added to all notifications declaring areas to be closed to lopping, granting permission to right-holders only, to stead their cattle in existing *kharaks* in these closed areas, as a special concession, provided there is no lopping. And the villager realises that if he does lop, the concession to occupy the *kharak* at all may be withdrawn. This has a most salutary effect and has really almost stopped lopping in such areas, or at least makes them lop to a very restricted extent on any one tree, so that the damage is very slight.

It is also difficult to make the villager leave the top 6 feet unlopped.

But both these difficulties are really matters for time and propaganda to improve.

What is totally impracticable about these latest rules is that while all *bona fide* residents of Kumaun may use *kharaks* outside fuel and fodder reserves, only right-holders may lop the trees round these *kharaks*. It will be realised at once that in the remote areas where *kharaks* occur, it is quite impossible for any Government staff to enforce this rule, unless the right-holders themselves enforce it on non-right-holders. There is no doubt that right-holders have become very jealous of their rights, but to expect them to act by reporting their neighbours to the forest staff is asking for too much at present, nor is it altogether desirable in the interests of peace. The other possible alternative is that right-holders may attempt to restrain others from lopping by force, and this is even less desirable.

What is likely to happen is that all will lop, and the destruction of forests continue

until the law is changed or the forest is declared a fuel and fodder reserve.

It was a great mistake *not* to limit the right to use *kharaks* to the same persons as are allowed to lop. If this could be done now, I think the rules as they stand are quite practicable, enforceable and would permit the maximum possible availment by the villager without too serious damage to the forest estate. The closure of areas as fuel and fodder reserves would then permit, if properly applied, the operation of rotational lopping schemes.

V—PROTECTED FORESTS

This is "Civil Forest" or waste land. Most of it lies in the immediate vicinity of villages. There has really been very little protection of these forests, until the impetus given to formation of Panchayat Forests in the period around 1931. Such of these forests as are left have now been mostly made into Panchayat Forest and almost all the others are moribund. It is in these forests that lopping and felling of *chir* has been most extensive. Illicit lopping and felling of *chir* in Class II reserved forest and legitimate lopping and felling of *chir* in Class I has been gaining momentum every year as the area of Civil Forest dwindles or becomes increasingly preserved in Panchayat Forests. As a general rule it may be said that the lopping of oak is almost entirely for fodder purposes while the lopping of *chir* is for fuel. It will be clear, therefore, that the lopping of *chir* is most prevalent in the more densely populated parts and particularly near towns where imports of fuel are not strictly controlled.

Thus the Civil Forests have so far provided almost all the fuel demands of villages supplemented by free grants and fallen fuel from reserved forests and lopping of *chir* has nowhere else been very serious except in the vicinity of Almora town. Now that most Civil Forests have been wiped out or declared Panchayat Forests, there will be an ever increasing pressure of lopping in any surviving Class I Forest near villages, together with more illicit lopping in the nearer Class II Forests.

Around Almora there was originally a very considerable area of protected Civil Forest. This has now almost completely vanished or been reduced to a growth of small bushes and young *chir*. Here also the illicit lopping of Class II forests and plantations has reached serious proportions, and can never be effectually checked except by control of imports of fuel into Almora. But this is very exceptional and generally the lopping of *chir*, except in Civil Forest, has never been a serious danger nor, so far as can be foreseen at present, is it ever likely to be such a very serious danger to the extent that it is in oak forests.

GLOSSARY OF VERNACULAR TERMS

I—BOTANICAL

DEODAR	...	*Cedrus deodara.*
TOON	..	*Cedrela toona.*
CHIR	...	*Pinus longifolia.*
SAL	..	*Shorea robusta.*
KAIL	..	*Pinus excelsa.*

II—GENERAL

PATWARI	...	Civil subordinate in charge of a *Patti*—a small sub-division of a district.
MALGUZAR	..	The headman of a village or group of villages.
KOKAT	...	Miscellaneous tree species.
BANI	...	A small group of trees, usually planted.
KHARAK	..	Steading for cattle inside forests.
SALASSI	..	Year 1880, the year of land settlement in Kumaun.
PANCHAYAT	...	Village Committee.

ENTOMOLOGICAL NOTES*

By J. C. M. Gardner
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6. The Chemical destruction of Forest Pests

This subject is discussed by L. I. Ossowski, Head of the Forest Department in the Polish Ministry of Reconstruction, in a very interesting article in *Endeavour* (1944, 3 (9): 32—37). The artificial replacement of natural forests in Europe by conifers, in large areas, usually of one species and of uniform age, has created a situation eminently suitable for the multiplication of certain pests, and of defoliators in particular. An idea of the enormous loss involved is given by definite figures: for example in Bavaria in 1895 the pine looper attacked 100,000 acres of conifer woods, in consequence of which five million cubic feet of timber had to be felled; in 1931—33 the cost of fighting the pine noctuid in one province of Poland alone amounted to £140,000.

Early attempts to control outbreaks, by raking the ground surface at the time when pupæ are formed, by collecting the moths or by tar-ringing the trees, although made on the grand scale, led to only moderate success. The first attempt to use chemicals was made in the U. S. A. in 1921 when a plantation of *Catalpa speciosa*, heavily attacked by defoliators, was dusted from an aeroplane with arsenate of lead. Owing to favourable (warm and dry) conditions 99 per cent. of the larvæ were killed. Trials in European forests left much to be desired owing to the fact that the efficacy of arsenic (an internal or stomach poison) depends on weather conditions; there is also the grave risk of poisoning mammals and birds.

In 1929 large-scale experiments were made by using so-called contact dusts. These have the effect of causing paralysis in the larvæ merely by coming into contact with the skin in contrast with internal poisons, which must be swallowed to be effective and which may be washed off by rain before the insects feed. The first dusts used were based on veratrin or rotenone or were derived from the root of *Derris robusta* (from India); various proprietary names were given to these products and several were used successfully. In accurate tests 98 per cent. of the larvæ were killed; treatment is required as soon as possible after emergence from the egg. These dusts have at most a very slightly irritating effect on the human mucous membrane but have the defect that they are less effective against hairy caterpillars.

In 1932 a great advance was made by adding pyrethrum to the dusts, making them effective against hairy caterpillars. This contains esters which act as nerve poisons to insects but not to man; it has the disadvantage of decomposing rather rapidly. Before the outbreak of this war a German firm evolved a preparation reported to be completely successful and harmless to mammals.

The dusts have been applied by motor dusters and aeroplanes, the autogyro being apparently the most suitable. An account is given of the method, based on precise counts of pupæ in the soil, of forecasting outbreaks.

The use of dusts in Indian forests is likely, as Beeson has pointed out, to be limited to nurseries, regeneration areas and exceptionally valuable stands in danger of extinction.

7. Bedbugs and Bean Leaves

It is the practice in the Balkan countries to trap bedbugs by spreading common bean leaves (*Phaseolus vulgaris*) on floors. One investigator records the collection of 2.25 lbs. of bugs in this way from one room alone; the bugs appeared to be dazed and reluctant to move from the leaves. An interesting account is given by Richardson (1943, *J. Econ. Ent.* 36: 543) of his investigation of this effect. He

* Continued from *The Indian Forester*, Vol. LXIX, No. 8, dated August, 1943, page 323.

finds that the leaves are neither attractant nor stupefying; the explanation is that the legs of the insect become entangled in the small hooked hairs present on both sides of the leaves. Leaves of several species without hooked hairs gave negative results; the seed pod, with hooked hairs, of another species successfully trapped the bugs.

This suggests a profitable line of enquiry in India (a new one here so far as I know) perhaps applicable to certain other pests.

8. Termites and Metal Shields

The secret of protecting susceptible materials from attack by soil-inhabiting termites is of course insulation from the soil. One accessory method generally advocated is the use of a metal shield projecting two inches horizontally and with a further two inches bent downwards at an angle of 45°; this shield to be complete and to separate the foundations from the upper susceptible material. (Details are quoted by Beeson, 1941, *Indian Forest Records*, 4, 2: 76.)

In 1942 I laid out simple experiments to test shields which were placed as caps on wood pillars; these pillars were used as the legs of a table six inches high, the horizontal surface of which consisted of susceptible wood. Rather disconcertingly termites (*Coptotermes* sp.) managed to continue their earthen galleries over the edge of one of the shields and to attack the "protected" wood above. That the metal shield is not infallible is confirmed by Johnston (1943, *J. Econ. Ent.* 36: 386) who tested a wide range of types of shields against *Reticulitermes flavipes* Kollar. He finds that every type of shield was crossed at least once by a termite gallery and that a simple shield projecting horizontally at least two inches gives as much projection as the shields bent downwards at 45° (the latter being far more difficult to install). The conclusion is that these shields give some protection but must be periodically inspected.

9. Faulty Application of Protective Measures

Sometimes methods advised result in apparent failure; when examination is possible it is often found that specifications have not been strictly adhered to and this especially when non-entomologists have attempted to apply often quite simple instructions. In most cases an explanation of the reasons for particular actions will prevent error. I recently inspected a large store of immense importance. The commodity in question was packed in large wooden cases stacked on supposedly termite-proof stands. These consisted of creosote-impregnated wood and the pillars, on which the bottom row of boxes rested, were provided with the metal caps referred to in the previous note. The store had been periodically and carefully inspected. Every precaution seemed to have been taken. In fact, however, each metal cap had been neatly slotted (pierced) centrally to allow the wooden pillar to pass through. This mistake might have been disastrous, for termites could have passed directly up the pillar and through the shield and their galleries could easily have been overlooked in the closely packed store. Any sense of security was completely false. The essential point of course is that the whole metal surface must be unpunctured. In this case, fortunately, the floor was of good concrete and all cracks had been efficiently closed; that this part of the procedure, at least, had been correctly done undoubtedly saved the situation.

THE DOUBLE COCONUT

By M. B. Raizada, M.Sc.
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The Double Coconut or Sea Coconut, *Lodoicea maldivica* Pers. (L. Seychellarum Labill.) was the most celebrated palm of early days, and yet there is scarcely any other palm about which so little is known. Its discovery has a very romantic history behind it. The French call it *coco-de-mer, coco-de-Salomon* and *coco-des-Maldives,* and it was known to the writers of the sixteenth and seventeenth centuries under the name of *Nux Medica* and *Cocos Maldivicus.* Until the discovery of the Seychelles, the only place in the world where this palm is indigenous, in the year 1743, by order of Mahe de la Bourdonnais, then Governor of Mauritius, the nuts were only known from having been found floating on the surface of the Indian Ocean, and near the Maldives Islands, whence their French name was derived and even in the time of Rumphius (1627—1702), the nut was spoken of as the "*mirum miraculum naturae, quod princeps est omnium marinarum rerum, quae rarae habentur.*" The nut only was found floating destitute of its husk, and mostly with the internal part decayed.

The first European who described this strange fruit was Garcia d'Orta who resided in Goa from 1534—1570 and was physician to the Viceroy at Goa for about 25 years. In this capacity he found leisure for private study which he spent in the exploration and description of the useful plants and drugs of the country. In 1563 he published the results of his investigations in his "Coloquios da India," which were soon translated into several modern languages, and into Latin by Clusius in 1567. Garcia knew that the nuts were obtained as jetsam on the shores of the Maldives, and that no one had ever seen the tree, The nuts cast ashore in the Maldives were then, and continued to be, a royal perquisite. They were obtained with the endosperm still in them, cut open and the endosperm converted into a special medicinal copra, sold at a very high price, with a reputation for curing many ailments and diseases. This copra was even taken to Europe, for Clusius relates that he saw it on sale in Lisbon. Garcia wrote: "This nut, and specially the kernel are recommended by the inhabitants of those islands (Maldives) as a remedy against poison. I have been told by many trustworthy people that it proved useful in colic, paralysis, epilepsy and other nervous diseases, and that the sick become immune against other diseases, if they drink water that has been left in the shell for some time, and to which has been added a piece of the kernel."

Da Costa, a Spaniard, who visited India while Garcia was still there, writes that drinking-cups, with a bit of kernel chained to the side, were made from the shell, and used because of their supposed power of preserving the user against all danger from poisoning; he, however, comments that he never saw any one cured by the drink. The price of these nuts, he adds, is, nevertheless, very great, a single nut without any ornaments being sold for 50 and more gold pieces.

Francois Pyrard, a French, who was shipwrecked on the Maldives in 1661, in an account of his adventures, gives the following short note on the Double Coconut: "The King has, besides his revenues, certain rights, *e.g.,* everything that is found on the seashore belongs to the King, and nobody has the courage to touch anything of the kind in order to keep it, but all must bring what they find to the King. whether it be a piece of wrecked ship, piece of wood, a box or other thing carried to the shore. The same applies with regard to a certain nut which is sometimes washed ashore. It has the size of a man's head and can be compared with two large melons grown together. People call it Tavarcarre and they believe that it comes from a tree growing at the bottom of the sea. It has medicinal properties and carries a high price."

More credulous than Clusius and Costa as regards the wonderful properties of the Sea Coconut is William Piso, a Dutch physician, who had travelled in Brazil between 1636 and 1641 and who, by his writings, added considerably to the scientific knowledge of the West Indies. He devotes a whole chapter, written in elegant Latin, regarding the qualities of this nut. He first of all excuses himself, because he gives the figures of the fruit only instead of the whole plant, but no one, he says, can expect the illustration of a plant which has been devoured by the sea and is growing at a depth of 16 fathoms. The introduction to the chapter gives a vivid picture of the high esteem in which the Double Coconut was held in former centuries and, at the same time, of the way in which scientific subjects were treated about 300 years back.

The most complete historical account of the Sea Coconut is given by Rumphius (*Herbarium Amboinense*, VI, 210), where he describes the marvellous fruit under the Dutch name "Calappa Laut;" but fabulous as it is, he tells us that many other tales were related to him regarding it, which were too absurd for him to detail. The Double Coconut is not, he assures us, a terrestrial production, which may have fallen by accident into the sea and there become petrified as Orta relates; but a fruit, probably growing itself in the sea, whose tree has been hitherto concealed from the human eye. The Malay and Chinese sailors used to affirm that it was borne upon a tree deep under water, which was similar to the coconut tree, and was visible in placid bays, upon the coast of Sumatra, but that if they sought to dive after the tree it instantly disappeared. The Negro priests declared it to grow near the Island of Java, with its leaves and branches rising above water in which a monstrous bird or griffin had its habitation, whence it used to sally forth nightly and tear to pieces elephants, tigers and rhinoceroses with its beak, whose flesh it carried to its nest. Furthermore, they avowed that ships were attracted by the waves which surrounded this tree and there retained, the mariners falling a prey to this savage bird, so that the inhabitants of the Indian Archipelago always carefully avoided that spot. Rumphius thinks that the Chinese as well as the natives of the Archipelago set, perhaps, too high a value on the medical properties of the nut in considering it an antidote to all poisons. The principal virtue resided in the meat or albumen which lines the nut and which is so hard and corneous as to be preserved for a length of time after the embryo is destroyed.

This substance was triturated with water in vessels of porphyry and mingled with black and white or red coral, ebony and stags' horns, was drunk, all together. Great men made precious vessels of the shell which possess fewer medicinal properties, by cutting off a transverse slice, which constituted the lid. In this they put their tobacco, betel lime, and whatever else they masticate, believing they could never then be contaminated by anything noxious.

With the discovery of the Seychelles or Mahe Islands, as they are sometimes called, in 1743 a new era began for the Sea Coconut, the object of so many legends and superstitions. La Bourdonnais was the first to discover the tree on one of the Seychelles Islands. He called it the 'Isle of Palms,' now known by the name of Praslin. Later on the tree was also found on Curieuse and Round Islands. These are within half a mile of each other, mountainous and rocky, and the soil poor. The common coconut (*Cocos nucifera*) occupies the sea coast, but all other parts are or have been entirely covered with Cocos de Mer. "To behold these trees," says Harrison, "growing in thousands, close to each other, the sexes intermingled; a numerous offspring starting up on all sides, sheltered by the parent plants; the old ones fallen into the sear and yellow leaf, and going fast to decay, to make room for the young trees presents to the eye a picture so mild and pleasing, that it is difficult not to look upon them as animated objects, capable of enjoyment and sensible of their conditions."

The Valley of the 'Coco-de-Mer,' though it sounds romantic, almost out of fairy tale, does,

really exist and it is the only place in the world where this strange palm is indigenous. Away in the Indian Ocean, in the Seychelles group of some 90 beautiful islands—"the Pearls of the Indian Ocean"—is the valley of Coco-de-Mer.

From the little port of Victoria in the main island of Mahe a motor boat crosses to Praslin twice a week. It takes her 4 hours to make the 25 miles crossing and the sea is often very rough. In Praslin there is a picturesque hotel, its 'rooms' consisting of separate palm-leaf huts on the very edge of the sea.

Although the trip to the Coco-de-Mer Valley can be made in time to return by the motor boat in the afternoon, a longer stay is enjoyable, that is, the three days until the next boat from Mahe arrives. A stiff climb of about three miles takes one to the valley. Past plantations of coconut and Vanilla, the rough path winds and at the top of the hill leads to a dense tropical jungle—dark and cool with black parrots—which like the Coco-de-Mer, are only found in Praslin—over head. Emerging from the jungle a sign board points that you are in the Coco-de-Mer Valley —and it lies before you, the great palms with their enormous nuts, growing up the steep banks on every side and the sun shining on their huge smooth leaves.

Although this palm had been discovered at last, it still took a long time before it was accurately described. Sonnerat in 1776 gave a description of it, though not a very scientific one, when on his tour to New Guinea he landed upon Praslin island. Later several botanists described the palm under different names: Gmelin called it *Cocos maldivica*, Giseke, *Borassus sonnerati*, Commerson, *Lodoicea callipyge*, Persoon, *L. maldivica* and La Billardiere, *L. seychellarum* who to the botanical description also added figures from specimens preserved in spirit, together with a representation of the tree from a drawing made by M. Lillet in the Seychelles. The description, however, was still deficient in many respects and it was W. J. Hooker who supplied the desiderata (*Bot. Mag.* t 2734, 5, 6) except that perfect representation of the mature nut was still wanting. This discrepancy has been supplied, in the meantime, by various botanists, and the once so mysterious Sea Coconut tree is now as well known as any other.

Description.—Trunk 18—30 m. high, straight, smooth, apparently destitute of bark, annulate about 30 cm. in diameter, with scarcely any difference in size to the very top. Leaves 12—20 m. large, 2.4—3 m. long, 1.5—1.8 m. broad (at times upto 6 m. long and 3.6 m. broad), the youngest arising from the centre, at first folded like a shut fan, and then clothed with a downy substance; later on broadly ovate with a central rib and regular folds diverging from it, margins more or less deeply cut, especially at the extremity; the colour bright yellow green; texture thin and dry. Spathes sheathing at the base of the spadices, small. Flowers dioecious. Male spadix from the axils of the leaves, amentaceous, 60—120 cm. long, 7.5—10 cm. in diameter in the thickest part, cylindric, covered on all sides with densely imbricated, semi-circular, slightly convex scales. When looking externally at these scales, a small aperture will be perceived, from which the stamens issue; and as this aperture, though near the base, is not in the centre of each scale, but constantly on one and the same side; and as the scales lap over with that side the one next above it, so the aperture and the stamens will be found to pass through both. The flowers in subreniform clusters in hollow of the axis; imbricated in two rows. Sepals and petals oblong, yellowish-brown, the sepal rather longer and more angular than the inner; filaments united at the base; anthers linear, 2-celled. Female spadix rising from the axils of the leaves, pendent, 60—120 cm. long, thick and woolly, tortuose, clothed with large, sheathing, red-brown scales, which are singularly fimbriated, or more generally erose at the margin, and support several, more or less distantly placed female flowers of different ages, at the same time, and of various sizes. Sepals and petals almost hemispherical and 2.5 cm. thick at the base; ovary almost concealed by the perianth, broadly ovate, narrow at the base above the insertion of the perianth. Fruit

oblique obovoideus, usually 1-seeded, mostly 2-lobed.

The Double Coconut is one of the giants among palms, its smoothened straight trunk frequently attains a height of 100 feet or more, and it is also a centenarian before its full growth is attained. As the sexes are separated it is not enough to grow a single palm in any one place. The palm flowers at the age of 15 years, and as the fruit takes about 3 years to ripen, it fruits first at the age of 18. The seeds are probably the largest known, the individual nuts being said to weigh sometimes 50—60 lbs., though the largest usually seen in collections do not likely exceed about 15 lbs.

According to Seeman [*History of Palms* (1856), 245] in the Seychelles "the tree grows on all kinds of soil, from the sandy shore to the arid mountain-top, but the finest are found in deep gorges, on damp platforms, covered with vegetable soil; in such situations, the great height and slender diameter of the trunk, and the length of its enormous leaves, produce a fine effect, though near the sea shore, its leaves, torn by the storms and hanging in long strips, give it a desolate appearance. It is regretted that the tree is not cultivated, and that a practice has prevailed of cutting it down in order to get at the fruit and tender leaves. In fact, it is feared that the species, will be, ere long, entirely lost."

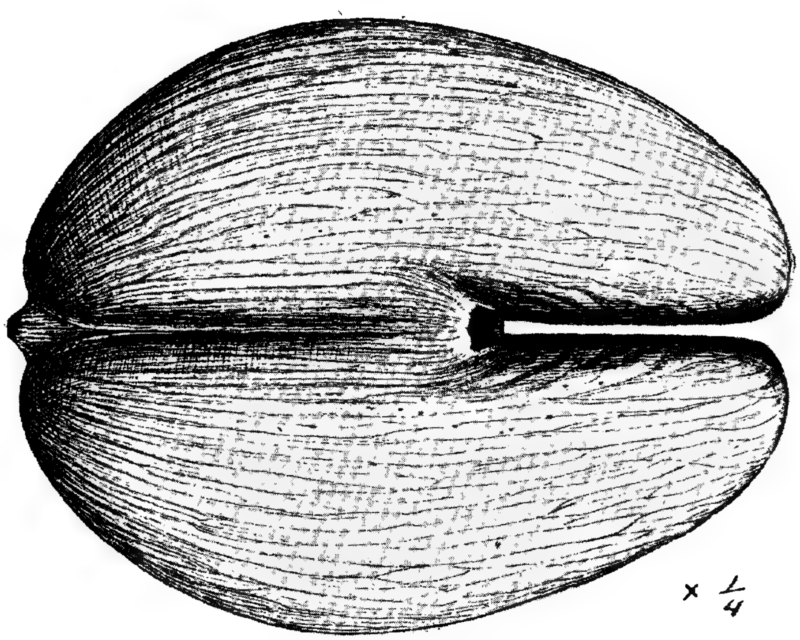
This danger of complete destruction of this noble palm has, however, been removed in the meantime. For Roth mentions that according to a suggestion of John Horne, then Director of Botanic Gardens of Mauritius, the Lodoiceas are, since 1875, under the protection of the Government.

It is a striking fact that the seeds, though capable of a wide oceanic dispersal which must have continued over a long period of time, in no case established themselves spontaneously in any new territory. This forms a strange contrast with the ordinary coconut, which, probably originally a native of South America, is now widely distributed throughout the tropics.

Economic and medicinal uses.—According to Hooker, in *Botanical Magazine,* the crown of the trunk, is eaten like that of the American cabbage palm (*Oreodoxa regia*); but it is less delicate, and slightly bitter; it is often preserved in vinegar. The trunk itself, after being split and cleared of its soft and fibrous part within, serves to make water troughs, as well as palisades for surrounding houses and gardens. The foliage is employed to thatch the roofs of houses and sheds, and even for the walls. With a hundred leaves a commodious dwelling may be constructed including even the partitions of the apartments, the doors and windows. The down which is attached to the young leaves serves for filling mattresses and pillows. The ribs of the leaves and petiole constitute baskets and brooms. The young leaves, carefully prepared, supply plaiting material for hats, etc. Out of the nut are made vessels of different forms and uses. When preserved whole, and perforated in one or two places, the shell serves to carry water. If divided into two, between the lobes, each portion serves, according to the size and shape for plates and dishes or more generally drinking-cups these being valuable from their great strength and durability. Among other articles, shaving dishes, black, beautifully polished, set in silver and carved, are made from them. The endosperm is hard enough to give vegetable ivory.

In India the half shell of this very curious fruit is a familiar object, as it is carried by *fakirs, sadhus* and priests as a water vessel.

The marvellous medicinal properties which were ascribed to the nuts by ancient physicians both European and Asiatic have now been recognised as fanciful and depended solely on the rarity of the fruit. It is consequently no longer valued by Europeans, but according to Dymock it is still in great repute among the Arabs and natives of India as a tonic, preservative and alexipharmic. In Bombay, it is prescribed as a tonic and febrifuge; it is used to check diarrhoea and vomiting, especially in cholera. It is also commonly given to children, mixed with root of *Nux-vomica,* for



The Double Coconut (*Lodvica maldivica* Pers.)

colic. The water of the green fruit or its soft kernel is said to be antibilious and antacid, when taken after meals.

It is, however, to be regretted that this tree is not extensively cultivated and that a practice has prevailed of cutting it down in order to get at the fruit and tender leaves, and it is to be feared that this was going to lead one day to the complete extinction of the Double Coconut, which will become in reality as rare as it was supposed to be by the travellers who picked up the first known specimens of its nuts floating on the sea.

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PLACE OF FODDER FROM TREES AND SHRUBS IN THE AGRICULTURAL AND FORESTRY ECONOMY OF MADRAS

By

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Foreword.—The note below was drafted in response to an enquiry from the Imperial Forestry Bureau and is necessarily somewhat brief. To any one interested in the subject the proceedings of the Central Fodder and Grazing Committee meeting in November 1939, with the various annexures are worth reading. I mention this as the suggestion to publish the note in the *Indian Forester* has just been made, and in these rather difficult days I find it impossible to write further notes in amplification.*

Generally speaking fodder from trees and shrubs in Madras must be considered as scarcity of fodder. The only exception which has come to my notice is the practice of feeding pods of *Acacia leucophlœa* (*syn. Ac. alba*) to high grade cattle in the Kangayam area of Coimbatore district, where expert breeders say that they give an extra bloom to the coat of the animal that means a higher sale value.

In common with the rest of India the cattle population of Madras is excessive. Especially is this so in dry areas and near areas of reserved forests where cattle of low efficiency and little value can scrounge a living at extremely low cost. The concentration of scrub cattle in such areas combined with the extension of agriculture to absorb waste lands previously at the disposal of the cattle has resulted in the complete denudation of grass cover over vast areas except during the relatively short monsoon period. In the reserved forests of the dry districts also the pressure of the grazing animal is high, and marginal areas are for the most part badly overgrazed. While the agriculturist provides for his utility animals during the hot weather he cannot afford to do so for his scrub animals. From February onwards therefore they have to depend on whatever cheap fodder they can pick up. From March onwards trees and shrubs put on new foliage and it is only natural that this should be lopped for fodder.

In the reserved forests lopping of trees is prohibited, the only exception being in Guntur district where the working plan has catered for the removal of the leaves of *Hardwickia binata* in times of fodder scarcity. In unreserves and waste lands however hot weather lopping is common and has ruined many thousands of acres.

Species which have been noted as popular from a fodder point of view, are:

Albizzia amara.—In one district the leaves of this tree are preferred to the natural grasses and the cattle which feed on them are known as *chigara* cattle, after the local name of the tree.

Acacia leucophlœa.—The pods are collected extensively and are considered in many parts of practically the same feeding value as a concentrate.

Acacia arabica.—The pods are frequently fed, especially to goats.

Prosopis juliflora.—The pods (two crops a year) are extremely palatable and are relished by cattle. This species is an exotic recently introduced.

Azadirachta indica.—Leaves are lopped—March or April. Selectively browsed by deer in young regeneration areas.

* An article on "Some Common Fodder-Yielding Trees in the Madras Presidency" by S. N. Chandrasekhara Iyyar and T. Venkataramana Reddy in two parts was published in the August and October, 1942 issues at pages 435 and 536 of Vol. LXVIII.—*Ed.*

Albizzia lebbek.—Leaves are very palatable at any time of the year especially the leaves of seedlings and young saplings. Elephants show a preference for them over most other species.

Tamarindus indicus.—Sheep and goats are very fond of the leaves. Fried tamarind kernels are fed to cattle in the west coast.

Dalbergia latifolia.—Leaves very palatable and seedlings are browsed selectively where available.

Hardwickia binata.—	Do.	Do.	Do.
Pterocarpus santalinus latifolia.—			Do.
Pterocarpus marsupium.—		Do.	Do.
Santallum album.—	Do.	Do.	Do.
Bombax malabaricum.—		Do.	Do.
Eriodendron anfractuosum.—		Do.	Do.

Bamboosa arundinacea.—
Dendrocalamus strictus.— } Both are lopped extensively in North Salem in seasons of fodder scarcity. Also very popular as fodder with elephants.

The view generally held both by forest officers and others is that tree and shrub fodder is taken mainly to meet abnormal conditions. It is likely to remain in demand at special seasons so long as the cattle population remains excessive and until measures are taken to ensure the reservation of adequate stocks of hot weather fodder by cattle owners. As pasture management improves, and methods for the storage of the excess forage produced during the monsoon become more popular, demand is likely to decrease, and the ultimate objective should be to eliminate altogether the use of tree or shrub leaf fodder, since lopping at the period of maximum activity of the plant can but be detrimental to its health. Meantime the policy is to grow fodder trees along with other species in all forest plantations in the dry districts so as to create a reserve against possible seasons of shortage. Where the problem is more acute, rotational lopping of selected species is indicated.

There is a strong feeling that the necessity of such leaf fodder would disappear altogether if the following far-reaching measures were taken:

1. A sound water and soil conservation policy launched in all dry districts. This in itself would increase the quantity of roughages from cultivated lands from 25—50 per cent., and in uncultivated lands the production of herbage could be doubled.

2. The more extensive introduction of improved pasture management where pastures exist. Natural pastures are found chiefly within the reserved forests. Improved pasture management involves the limitation of the number of cattle admitted to the carrying capacity and the improvement of the carrying capacity by complete closure, deferred grazing, or rotational grazing as the case may be.

3. The storage of surplus monsoon fodder by ensilage or hay-making in suitable areas.

Feeding Value of Tree and Shrub Fodders.—Though no systematic study as to composition and nutritive values exists, studies of a few species show tree leaves to be richer in nutrients than other non-leguminous fodders. They are generally high in protein and lime, but rather low in phosphorus. Digestive coefficients have not been tested to any extent. Such tests as have been done, however, indicate that tree leaves have an energy value equal only to poor dry roughage such as straws. They are, however, superior to straws in their content of digestible crude protein.

SUMMARY OF REVENUE AND EXPENDITURE OF THE FOREST

Heads	Ajmer-Merwara	Andamans	Assam	Baluchistan	Bengal	Bihar	Bombay
Revenue— Timber and Other Products—	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
Average of three years ending 31st March, 1941 ..	48,992		19,50,757	1,58,312	24,12,374	8,57,724	41,24,860
1941-42 ..	49,480		32,94,610	2,10,882	32,17,269	10,60,235	69,76,090
1942-43 ..	88,453		37,37,351	1,95,569	38,37,545	14,22,335	1,13,09,747
Expenditure— Conservancy, Maintenance and Regeneration—							
Average of three years ending 31st March, 1941 ..	16,487	Not available	3,71,940	97,378	6,93,271	1,71,764	7,29,374
1941-42 ..	16,397		7,94,629	1,46,893	9,90,171	1,94,953	13,48,177
1942-43 ..	27,674		15,69,669	1,92,674	14,51,460	2,19,329	45,48,900
Establishment—							
Average of three years ending 31st March, 1941 ..	28,206		8,18,454	37,421	10,38,982	4,23,707	19,79,211
1941-42 ..	30,210		8,86,639	42,207	10,80,183	3,78,596	20,80,593
1942-43 ..	28,441		9,57,195	50,212	10,99,351	4,08,910	22,33,556
Total of Expenditure—							
Average of three years ending 31st March, 1941 ..	44,693		11,90,394	1,34,799	17,32,253	5,95,471	27,08,585
1941-42 ..	46,607		16,81,268	1,88,459	20,70,354	5,73,549	34,28,770
1942-43 ..	56,115		25,26,864	2,42,885	25,50,811	6,28,239	67,82,456
Surplus (+) or Deficit (—)							
Average of three years ending 31st March, 1941 ..	+4,299		+7,60,363	+23,513	+6,80,120	+2,62,253	+14,16,274
1941-42 ..	+2,873		+16,13,342	+22,424	+11,46,915	+4,86,686	+35,47,320
1942-43 ..	+32,338		+12,10,487	—47,316	+12,86,734	+7,94,096	+45,27,291

DEPARTMENTS IN INDIA FOR THE FINANCIAL YEARS 1941-42 AND 1942-43

Central Provinces and Berar	F. R. I. and College	Imperial	Madras	North-West Frontier Province	Orissa	Punjab	Sind	United Provinces
Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.	Rs.
53,56,784	1,59,201	..	34,37,780	6,76,759	6,97,289	28,04,087	8,43,920	61,00,110
73,86,923	1,68,200	..	48,91,402	12,89,002	6,70,349	50,35,720	8,90,724	94,63,602
1,42,75,313	2,41,101	..	69,77,674	15,80,873	13,18,632	63,88,291	15,34,330	1,20,73,792
15,95,332	89,613	..	13,16,549	2,11,569	3,06,228	13,84,770	44,432	12,01,803
30,54,107	1,21,885	..	12,30,904	3,29,321	1,87,293	18,01,899	55,213	14,44,314
63,89,675	1,69,195	..	24,72,935	5,61,603	5,66,106	23,62,535	89,021	25,95,828
19,93,996	6,27,612	48,916	25,47,180	1,99,622	3,49,964	12,37,620	3,23,880	18,30,165
20,54,231	6,62,100	54,407	24,24,674	1,94,072	3,76,714	12,98,195	3,33,516	19,59,007
23,08,860	7,16,127	49,070	24,93,933	1,99,925	3,80,368	14,66,326	3,34,179	23,13,201
35,89,328	7,17,225	48,916	38,63,729	4,11,191	6,56,192	26,22,390	3,68,312	30,31,968
51,08,338	7,83,985	54,407	36,55,578	5,23,393	5,64,007	31,00,094	3,88,729	34,03,321
86,98,535	8,85,322	49,070	49,66,868	7,61,528	9,46,474	38,28,861	4,23,200	49,09,029
+17,67,456	—5,58,024	—48,916	+5,74,050	+2,65,568	+41,097	+1,81,697	+4,75,608	+30,73,387
+22,78,585	—6,15,785	—54,407	+12,35,824	+7,65,609	+1,06,342	+19,35,626	+5,01,995	+60,60,281
+55,76,778	— 6,44,221	—49,070	+20,10,806	+8,19,345	+3,72,158	+25,59,430	+11,11,130	+71,64,760

MULTIPLE LAND USE

BY M. V. EDWARDS

(Deputy Conservator of Forests, Burma)

The subject of the 1942 meeting of the Society of American Foresters was to have been the "Multiple Resources of Wild Lands in the Mountain and Intermountain Regions of the United States." Although the meeting was not held on account of the war, papers on the subject of "Multiple Land Use" are being published in the Society's journal.

In the Western States it is said, "a general lack of water results in low timber, grass and agricultural production per acre wherever unaided by water from other lands. In few other parts of the world are communities as interested in the way timber and range management, recreational use and mining *upon distant lands* affect the quantity and quality of water for agricultural, domestic and industrial uses." It can be said of India, too, that there are places where a general lack of water results in low production wherever unaided by water from other lands, but can it be said that here the community is interested in the way timber and range management, recreational use and mining, affect the water supply? In the United States of America the Society of American Foresters has been challenged by the question: "Is forestry wild land resource management, or is forestry confined to trees?" On the answer given to this will depend the whole constitution and outlook of the Society. Will it be able to enlarge its interest to cover the whole topic of multiple land use or will it issue a strict "Trees only"?

Willy-nilly, the foresters of India and Burma must face the same question because, important as planning for multiple land use may be in America, it is hard to imagine any place where it is as necessary as in India and Burma.

Here it is all too easy for foresters living a rather lonely life of touring to become separated from others interested in different forms of land usage, especially when forests are state-owned and organised and many of the other uses of land are left to private enterprise. If we are to listen to the cry of national leaders and set out seriously to improve the welfare of the villager of India and Burma, such lack of co-ordination cannot be permitted any longer, and the villager's agriculture, his cattle production and his grazing land, his fuel supply and his forest land, the preservation of wild life and the recreational use and amenities of the country, must all be related to one another and each regulated so that none become suppressed.

Will the foresters of India respond to this challenge to tackle "multiple land use"? Shall we, as the Americans put it, "stay inside our little 'tree-house' "? or can we join them in applauding the recent words of Edward H. Carr, in the *London Times*, "The old world is dead. The future lies with those who can resolutely turn their backs on it and face the new world with understanding, courage and imagination."

THE ANDAMAN FORESTS AND THEIR REGENERATION—IV*

By B. S. Chengapa, P.F.S.

(Formerly Assistant to the Chief Forest Officer, Andamans)

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CHAPTER VIII—PROBLEMS OF THE FUTURE

DETERMINATION OF THE NUMBER OF WEEDINGS NECESSARY

Though the main technique of raising regeneration in the Andamans is fairly well standardized, there is still considerable scope for research in tending the future crop from the seedling stage. At present only a fringe of this work has been touched. In the past, in our anxiety for success, undue attention was paid to the young crop, especially *padauk,* weeding them three or four times and sometimes five times a year and continuously for three years. In 1937 coolies from India arrived late and consequently only one weeding could be done in 1937 areas, instead of the usual three or four weedings in the first year. Yet, the young crop did not seem to have suffered any setback. In fact the 1937 areas were amazingly good everywhere. Experiments are, therefore, still necessary to find out the minimum amount of weeding required to

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* Parts I, II and III of this article have been published in the *Indian Forester* of September, October and November, 1944, respectively.

obtain an adequate crop of the required species.

INVESTIGATION ON CLIMBER CUTTING, CLEANING AND THINNING

Climber cutting, cleaning and thinning form another subject that requires close investigation. In Guitar Island (calcareous soil), the 1933 area was thinned heavily, reducing the crop to lines eight feet apart when the crop was only two years old. The young crop responded surprisingly well and was in need of a second thinning in 1940. Similar thinning was carried out in Porlob (dry sandy loam) in a crop four years old (1931 and 1932 areas thinned in 1935). The response was very poor and a good deal of money was spent in cutting climbers that fast invaded this area. The crop had not recovered (in 1941) from the shock of too early and too heavy thinnings. The 1933 areas in Porlob and in Bajalungta were lightly thinned after five years, *i.e.*, the crop was reduced to an espacement of about one-third of their own height. The response was excellent, so much so that it became evident that the thinning was far too light. Although it was considered that a young crop, in dry sandy loam, can be thinned at the age of five, further experiments are necessary to determine the best intensity of thinning and also the interval for subsequent thinnings.

INVESTIGATION ON THE BEST MIXTURE

Padauk is definitely of primary importance in the Andamans as it is the best general utility timber. It should not, however, be forgotten that there are many excellent subsidiary timbers in the deciduous forests which should never lose their place in the crops. This is especially necessary in view of the financial promise of first-class peeling woods. By nature *padauk* is a low-branching tree and it seems absolutely necessary that it should be grown only in mixtures. One of the most remarkable things is the power that young *padauk* has of thrusting its way through dense canopy, even the canopy formed by saplings of such dense-crowned species as *badam* (*Terminalia procera*) and white *chuglam* (*Terminalia bialata*). It appears quite possible to grow *padauk* in mixture with most of the Andaman species. It also appears that the forest of the future will be most easily handled if it is reduced to a series of mixtures of *padauk* and one other species in each mixture in addition to the match log species, *i.e.*, *dhup* and *papita* (*Sterculia campanulata*). Thus the mixture may be *padauk* and white *chuglam*, *padauk* and *pynma* (*Lagerstrœmia hypoleuca*), *padauk* and *badam*, etc.; the main thing, however, will be to see that over-zealous staff does not create a pure *padauk* forest. Intensive experiments to solve this riddle are still needed.

INVESTIGATION ON THE EFFECT OF RAPID GROWTH ON MATCHWOOD SPECIES

The great speed at which our match logs are quite obviously growing under the even-aged conditions in our regeneration areas was causing great anxiety. It is feared that *papita* specially, brought up under these conditions, will be of such loose texture as to be of little value for making splints. In fact such logs are not an uncommon feature even now, although we have had only naturally-grown *papita* for sale so far. A disc from a log of this nature rejected by the match factory, and also one from a normal sound log, were examined by Dr. Chowdhury. Wood Technologist, Forest Research Institute. His observations are that "on superficial examination, it was found that the defective log had extremely eccentric growth—the radius from the pith to the bark varying from eight inches to as much as 23 inches. The wood was, however, uniformly very soft throughout the section. It was, therefore, very doubtful whether the eccentric growth was in any way responsible for the unusual softness of the wood. Then it was thought that the defective log might have had a faster rate of growth than normal timber. But on counting rings, it was found that the difference between the defective log and normal timber was so slight that any such view could not be entertained.

"Lastly on microscopic examination the following results were obtained:

Normal specimens (from Forest Research Institute collections.)	*Defective Specimens.*
1. Extremely interlocked fibre.	Slightly interlocked fibre.
2. Ray width normal.	Ray width much above the normal.
3. Fibre mostly medium thick-walled.	Fibre extremely thin-walled.

From the above data it will be seen that the anatomical structure, which is responsible for the softness of the defective log, is its cell-wall thickness.

"To verify this, the weight of this wood was determined for it is mainly the cell-wall material in wood that gives weight. The oven-dry weight of normal *papita* varies from 23 to 26 lbs. per cubic foot but in the defective timber, the weight was found to vary from 13 to 16 lbs. It can, therefore, be said that the softness of this defective timber is due to unusually thin cell walls.

"The final problem is to decide what has been responsible for the formation of such thin walls in the defective log. From a microscopic examination it is not possible to give a reply to this question. Most probably it is due to some defective environmental and physiological conditions in which the tree grew in the forest, but it would be interesting to know if any one can throw any light on the subject."—*Indian Forester* for September, 1934, page 602.

CORRECT ROTATION FOR DIFFERENT SPECIES

Correct rotation for different species, or at least for hardwoods and softwoods grown in the Andamans, is another problem yet to be solved. Growth-rings, except in white *dhup* and *papita*, are indistinct in all other species. In the absence of any accurate data, the exploitable girth was fixed at:

Nine feet for *padauk* and *gurjan*,
Eight feet for white *chuglam*,
Six feet for white *dhup* and *papita* and
Seven feet for others.

The rotation is fixed at 150 years for *padauk* and *gurjan* and 80 years for *papita* and *dhup*. Both these are based on insufficient data.

CHAPTER IX—ATTEMPTS MADE TO SOLVE THE FUTURE PROBLEMS

Both local staff and the Forest Research Institute Staff (Silvicultural Branch) were working hard for the solution of the problems of the future and laid out the following experiments.

Experiment to reduce cost of weeding

EXPERIMENTS TO DETERMINE THE NUMBER OF WEEDINGS NECESSARY IN THE FIRST YEAR

In a wholesale regenerated area in Kyitong two plots, five acres each, were laid. In Plot I weeding was done only once in July for the whole year. In Plot II two weedings were done, one in June and the other in November elsewhere in the area, the usual weedings were carried out. At the end of the year, Plot I did not appear to have suffered any setback but, unfortunately, due to some misunderstanding, no separate accounts of cost incurred in each plot were maintained, nor were they repeated.

WEEDING IN LINES STEWART ISLAND EXPERIMENT

In Steward Island an area of 16 acres was demarcated and plants, especially of *padauk*, were lined out 10 feet apart, using the seedlings found within the area. The area was weeded thoroughly once and every subsequent weeding was done along the lines only, the idea being that, at every weeding only three-tenths of the area was covered, thereby reducing the cost of weeding.

PORLOB ISLAND EXPERIMENT LINE WEEDING

In an area where the usual regeneration fellings had been carried out, 40 acres were demarcated. In this area only strips three feet wide were weeded. The intervening space of 10

feet between the strips was neglected. This amounted to weeding over only ¼ of the area. In the first year, the cost of weeding was found to be about 63 per cent of what it costs to weed the whole area. It was doubtful whether this would stand the test of large scale operations because of the difficulty in laying out and maintaining lines, and also of the necessity of later dealing with climbers and the fast growing miscellaneous weed growth in the non-weeded strips.

BAJALUNGTA EARLY TREATMENT EXPERIMENT

Fellings of marketable timber start about May or June of the year in which initial fellings for regeneration are to take place. This is completed before the end of November. Preparatory work of felling undergrowth and girdling unwanted trees, etc., is carried out from November to December of the same year.

Under the "early treatment" the clearing of brushwood and small trees is carried out more or less before, and also along with the fellings of marketable timber. The result is that the seedlings of that season do not die off as they would otherwise do. Seedlings, therefore, start in the same year as the climbers and weeds which the light opening of the canopy, caused by the removal of marketable timber, induces. An experimental area of 47 acres was thus treated, and it was claimed that this method reduced the costs considerably.

It must be remembered that, in this method, much of the extraction of timber is carried out after the seedlings appear. Therefore a certain amount of damage to the future crop is unavoidable. Also, much of the brushwood that is cleared, especially for regeneration in this case, usually comes out (in the case of ordinary regeneration) in the course of exploitation fellings and extraction of timber. Regeneration fellings after exploitation fellings and extraction of timber are, therefore, cheaper and past experiments have shown that regeneration should follow extraction closely to effect reduction in costs. It does not result in any reduction of cost in extraction of timber either, as the brushwood cut down has to be cleared separately for purposes of timber extraction.

As fellings of exploitable timber go on until the end of November, and sometimes December, and the actual germination of the future crop takes place early in June, it will not be practicable to apply this method over even half of the area due for regeneration.

However, whether this method results in a saving or not, its successful operation necessitates far greater knowledge of the silvicultural requirements of the species than is known at present. Experiments in this direction are, therefore, necessary to determine the minimum individual light requirements of the future crop during their first year of life.

Experiments to determine the best interval for thinning and also the best intensity for thinning

EXPERIMENTS TO DETERMINE THE BEST INTERVAL

The year *in which thinnings* should be carried out is far from fixed. From the results of the past experiments (results of which are by no means conclusive) thinnings have been provisionally fixed at five and ten years. So far there has been no hope of selling thinnings. It is, therefore, necessary to make a compromise between silviculture and financial expediency. The tenth-year and subsequent thinnings may have to be made heavier (if the silvicultural requirements of the crop allow it) to avoid frequent thinnings. Extensive experiments in this direction are still necessary.

EXPERIMENTS TO DETERMINE THE BEST INTENSITY

The aim is to regenerate 10 square miles or 6,400 acres per year based on a rotation of 150 years and an area of 1,500 square miles. Though this ideal cannot be achieved for some time, at least a minimum of 2,000 acres will be regenerated annually in future. Provisionally, it has been fixed that

thinning should be carried out at the fifth and tenth years. The intervals for subsequent thinnings is still a matter of guess, it may be 10 years. It is, therefore, clear that in future there will be more than 4,000 acres for thinning. The staff, as at present constituted, is hardly sufficient to cope with this task. It is, therefore, necessary to make the first and, if possible, the second thinning automatic and foolproof to enable the subordinate staff to carry on without much expert supervision. To attain this object, the crop in a regeneration area was divided into three classes—poor, medium and good—based on the average height of the dominant trees. In each class, four plots of $\frac{1}{2}$ an acre each were laid out. In:

Plot I—The crop was thinned to an espacement of one-fifth to one-fourth the average height of the crop.

Plot II—The crop was thinned to an espacement of one-third to two-fifths the average height of the crop.

Plot III—The crop was thinned to an espacement of two-fifths to half the average height of the crop.

Plot IV—The crop was thinned to an espacement of half to three-fifths the average height of the crop.

All trees were numbered and their heights and girths were recorded.

Elsewhere thinning was being carried out at an espacement of one-third height. Though the examination in 1941 of thinned areas and also the experimental plots showed no reason to change the espacement of one-third height for the first thinning provisionally fixed in 1938, it is absolutely essential to continue experiments in this direction to determine the best spacing at the first and also at the second thinning. It is doubtful whether it will be possible to carry out subsequent thinnings mechanically.

FOREST RESEARCH INSTITUTE EXPERIMENTS IN REGENERATION AREAS TO DETERMINE THE EFFECT OF VARIOUS GRADES OF FIRST THINNING IN PURE CROPS. PLOTS 11—16, 17

The object of this experiment was to find out in a pure crop the effect of three grades of thinning, viz., light, moderate and heavy, on their diameter and height growth, crown development, differentiation of stems and intensity of climbers. To attain this object, seven well-stocked plots of about quarter acre each were laid with a surround 30 feet wide where such surrounds were available. Thin and also suppressed trees were cut out. Diameters of all standing trees at $4\frac{1}{2}$ feet from ground level were measured and recorded. The heights of about 30 standing trees, in each plot selected at random, were also measured and recorded. After determining the crop and top diameters, heights, basal area and number of stems per acre in each plot, six of them were formed into three sets of two comparable plots each.

These were treated as follows:

First set of two plots of pure pynma—*five years old—Bajalungta, F. R. I. Plots 12 and 15.*

Light thinning—thinned to about 1,200 plants per acre, the plants retained being of good form, clean boles and evenly spaced.

Second set of two plots of pure pynma—*five years old—Bajalungta, F. R. I. Plots 11 and 16.*

Moderate thinning—thinned to about 1,000 stems per acre, the plants retained being of good form, clean boles and evenly spaced.

Third set of two plots of pure pynma—*five years old—Bajalungta, F. R. I. Plots 13 and 14.*

Heavy thinning—thinned to about 800 plants per acre, the plants retained being of good form, clean boles and evenly spaced.

The seventh plot was treated as follows:

One plot of pure pynma—*five years old—Bajalungta, F. R. I. Plot 17.*

Mechanical thinning—56 per cent. of the standing crop was removed, leaving 884 trees per acre.

The surrounds in all cases were thinned to the same intensity as the plots they surrounded. All these plots were due for observation and further treatment in 1943.

FOREST RESEARCH INSTITUTE EXPERIMENTS IN REGENERATION AREAS TO DETERMINE THE EFFECT OF FIRST MODERATE AND HEAVY THINNINGS IN A MIXED CROP

The object of this experiment was to see how the principal species in a mixed crop would react to two different grades of first thinning, viz., moderate and heavy, as regards their diameter and height growth, crown development, differentiation of stems and intensity of climbers.

To attain this object, a series of well-stocked plots of an average area of .22 acre with a surround varying from 30—50 feet all round were laid. In these plots, very thin and suppressed plants were cut out. Diameters of all trees at 4½ feet from ground level were measured and recorded. The heights of the standing trees in each plot were also measured and recorded. After determining the crop and top diameters, heights, basal area and number of stems per acre for each plot, they were grouped into a number of sets of comparable plots for comparison in future and were subjected to the following treatment:

First set of three plots of white dhup *in a mixture with other species—six years old—Bajalungta, F. R. I. Plots 18, 20 and 22.*

Moderate thinning—thinned to about 550 trees per acre, evenly spaced and of good form and clean boles.

Second set of three plots of white dhup *in a mixture with other species—six years old—Bajalungta, F. R. I. Plots 19, 21 and 23.*

Heavy thinning—thinned to about 400 trees per acre, evenly spaced and of good form and clean boles.

One plot of white dhup *in a mixture with other species—five years old—Porlob F. R. I. Plot 10.*

The main object is crop increment.

Mechanical thinning—60 per cent. of the standing trees were removed aiming at a 50 per cent. stocking of white *dhup* in the future crop. Five hundred and eighty-nine trees per acre (292 white *dhup* and 297 others) were left in the plot after the first thinning.

In these plots, except No. 10, diameters of trees above 1.5 inch only were recorded. The heights of 16—26 trees only in each plot selected at random were measured and recorded. The surrounds were thinned to the same intensity as the plots they surrounded.

In plot 10 no surround was available. All other works usually done in a sample plot were carried out.

First set of two plots of padauk *in a mixture with other species—four years old—Stewart Island—F. R. I. Plots 31 and 32.*

There were 1,080 plants (649 *padauk*) per acre in Plot No. 31 and 1,057 plants (649 *padauk*) in Plot 32.

Second set of two plots of padauk *in a mixture with other species—four years old—Stewart Island—F. R. I. Plots 33 and 34.*

There were 673 plants (486 *padauk*) per acre in Plot No. 33 and 749 plants (594 *padauk*) in Plot 34.

Third set of two plots of padauk *in a mixture with other species—four years old—Stewart Island—F. R. I. Plots 35 and 36.*

There were 830 plants (418 *padauk*) per acre in Plot No. 35 and 845 plants (429 *padauk*) in Plot 36.

No surround was available and no thinning was done in these plots.

One set of two plots in three species mixture of padauk, *white* dhup *and* papita*—six years old—Bajalungta—F. R. I. Plots 39 and 40.*

There were 1,347 plants per acre (*padauk* 667, *papita* 368, white *dhup* 312) in Plot No. 39 and 851 plants (*padauk* 370, *papita* 136, white *dhup* 344) in Plot 40.

A surround of 30 and 50 feet was demarcated around Plots 39 and 40 respectively and no further work was carried out in any of these plots.

One set of two plots in two species mixture of pynma *and* padauk*—three years old—Bajalungta—F. R. I. Plots 37 and 38.*

There were 5,578 plants (*pynma* 3,933, *padauk* 1,645) in Plot 37 and 7,916 plants (*pynma* 4,600, *padauk* 3,316) in Plot 38.

A surround of 30 feet was demarcated and no thinning was carried out.

All these Forest Research Institute plots were due for observation and for further treatment in 1943.

F. R. I. experiments mainly in plantations to determine the effect of C and D grade thinnings on crop increment.

The object of this experiment was to see how the principal Andaman species would react to C and D grade thinnings as regards crop increment.

To attain this object, series of plots varying in extent from .5 acre to 5 acres with a surround also varying from 50 to 100 feet were laid. All trees in these plots were measured and recorded. In the case of *padauk* because of their tendency to develop buttress in their later stages, two diameters, one at 4½ feet from ground level and the other at 10 feet from ground level were recorded. After the usual calculation preliminary in a sample plot, they were subjected to the following treatment and observations:

Sample plot of pure padauk *in Wimberlyganj plantation—46 years old at the time of formation—now 60 years old—F. R. I. Plot 4.*

This was formed in 1930; no thinning was done then as the trees were scattered and were only 48 per acre. C/D grade thinning was prescribed. In 1938 they were thinned to 42 trees.

Sample plot of pure padauk *in Wimberlyganj plantation—45 years old at the time of formation—now 59 years—F. R. I. Plot 3.*

This was formed in 1930 and no thinning was done as the crop was open then with only 56 trees per acre. In 1938, the plot was thinnned to 48 trees.

Sample plot of pure padauk *in Wimberlyganj plantation—26 years old at the time of formation—now 40 years old—F. R. I. Plot 2.*

This was formed in 1930 and no thinning was done as the crop was open then with only 200 trees per acre. C/D grade thinning was done in 1938 and the number of trees were reduced to 140 per acre.

Sample plot of pure padauk *in Wimberlyganj plantation—24 years old at the time of formation—now 38 years—F. R. I. Plot 1.*

This was formed in 1930. Apart from the removal of a few inferior stems to even up the crop, no thinning was done at the time of formation. There were then 155 trees per acre. A C-grade thinning was carried out in 1938, reducing the number of trees to 129 per acre.

Sample plot of pure padauk *in Bomlungta plantation—10 years old at the time of formation—now 24 years—F. R. I. Plot 8.*

This was formed in 1930; C-grade thinning was carried out, reducing the number of stems to 190 per acre, suppressed trees being left. Teak originally planted with *padauk* was allowed as a subsidiary species and no *padauk* to free teak ever being felled. C/D-grade thinning was carried out in 1938 reducing the number of stems to 100 per acre.

Sample plot of pure pynma *in Long Island plantation—10 years old at the time of formation—now 16 years—F. R. I. Plot 24.*

This was formed in 1938; C-grade thinning was carried out, leaving 294 trees per acre.

Sample plot of pure pynma *in Sound Island plantation—nine years old at the time of formation—now 15 years—F. R. I. Plot 26.*

This was formed in 1938; C/D-grade thinning was carried out, reducing the number of stems to 327 trees per acre.

Sample plot of pure Ywegi *(Adenathera pavonina) in Sound Island plantation—nine years old—now 15 years—F. R. I. Plot 27.*

This was formed in 1938; C/D-grade thinning was carried out, leaving 355 trees per acre. No surround was available.

Sample plot of pure padauk *in Sound Island plantation—nine years old at the time of formation and now 15 years—F. R. I. Plot 25.*

This was formed in 1938. Thinned to C/D-grade, leaving as far as possible 233 straight-boled trees per acre.

F. R. I. EXPERIMENTS TO COMPARE THE EFFECT OF C/D AND C-GRADE THINNINGS ON DIAMETER, ETC., GROWTH IN PLANTATIONS

The object of this experiment was to compare the effect of C/D and C-grade thinnings on diameter and height growth. Crop volume, crown development, differentiation of stems, straightness of boles, branchiness and intensity of climbers.

To attain this object three plots varying in extent from .5 acre to .8 acre with a surround of about 50 feet were laid. These plots were thinned to C and C/D-grade, leaving straight-boled well-formed trees as far as possible. The height of bole to the main crown, the condition of the bole as regards its straightness, the height of bole to the first green branch, the thickness of branches in comparison with the thickness of the stem at the point of formation were estimated and recorded and the individual plots were subjected to the following treatments:

Sample plot of pure padauk *in Sound Island plantation—eight years old at the time of formation—now 14 years—F. R. I. Plot 28.*

This was formed in 1938, was thinned to C/D-grade and mainly intended for comparison with Plot 29. After thinning there were 245 trees per acre in this plot.

Sample plot of pure padauk *in Sound Island plantation—eight years old at the time of formation—now 14 years—F. R. I. Plot 29.*

This was formed in 1938 and was thinned to C-grade and mainly intended for comparison with Plot 28. There were 321 trees per acre on the plot after thinning.

Sample plot of pure padauk *in Sound Island plantation—six years old at the time of formation—now 12 years—F. R. I. Plot 30.*

This was formed in 1938 and was thinned to C-grade, leaving 340 trees per acre.

All these plots were due for observation and for further treatment in 1943.

SAMPLE PLOTS OF PURE TEAK IN WIMBERLYGANJ AND BOMLUNGTA PLANTATION—F. R. I. PLOTS, 5, 6, 7

Teak is not indigenous to the Andamans and was introduced in 1883. Teak plantations continued to be formed until 1928. In the beginning it showed promise of great success but later its growth was found to be stunted and in some places the trees became stagheaded. Further planting of this species was therefore, discontinued. Therefore, this species is not of importance from the forest management point of view. However, with a view to find out the crop increment, three plots varying in extent from .5 to 1 acre were laid out in 1930 and were treated as follows:

F. R. I. Teak Sample Plot No. 5—planted in 1887—Wimberlyganj.

Formed in 1930; was thinned to C/D-grade, reducing the number of stems to 150. This was again thinned heavily in 1938, reducing the number of stems to 79 per acre (one-third of the basal area).

F. R. I. Teak Sample Plot No. 6—planted in 1918—Bomlungta.

Formed in 1930; was thinned to C/D-grade, reducing the number of stems to 297 per acre. In 1938 the trees were found very unhealthy and dying back. No thinning was done as some trees had already been removed by the Divisional Staff by mistake.

F. R. I. Teak Sample Plot No. 7—planted in 1918—Bomlungta.

Formed in 1930; was thinned to C/D-grade, reducing the number of stems to 226 per acre. In 1938 this was again thinned to 133 trees per acre.

F. R. I. SAMPLE PLOTS OF PURE MANGROVE—BOMLUNGTA

Mangrove occupies an area of 450 square miles, *i.e.*, 18 per cent. of the total area of the Andamans. At 160 tons per acre (Sir Alexander Roger's estimate) the total volume of timber is 46,080,000 tons, most easily accessible. Though no demand at present exists for them, like all other miscellaneous species that have sprung into market since last world war, these also are bound to take their place in the world timber markets. Any data on their growth, etc., will, therefore, be most useful.

F. R. I. Sample Plot No. 9 of Bruguera gymnorbiza—*Bomlungta.*

The object was crop volume and increment. This was formed in 1930. The diameter was measured at 10 feet from ground level. After removing a few trees in thinning the number of stems was 100 per acre. In 1938, it was found that no response had been made to thinning as the crop was already mature. In 1938 the number of trees was 95 per acre.

All these plots were due for observation and for further treatment in 1943.

EXPERIMENTS TO DETERMINE THE BEST MIXTURES

The crop now secured is an intimate mixture of all useful species of both hard and soft woods. This is not considered a good mixture and it is feared that it may complicate future management because of differences in growth and also in their exploitable age. Experiments were, therefore, in progress to determine whether these crops could be converted—

(1) Gradually into pure areas of reasonable extent.
(2) Immediately into pure areas.
(3) Immediately into two species mixtures.

EXPERIMENTS TO CONVERT GRADUALLY INTO PURE AREAS OF REASONABLE EXTENT

The object is to attain purity within 10 or more years, while retaining the mixed nature of the crop in the early period in order that refractory species such as *padauk*, which has a tendency to branch low when grown pure or isolated, can be forced to grow clean and straight. To attain this object a number of plots each of three to four acres were laid out. In each plot, the predominating species was determined and specially favoured, gradually eliminating all others. In this case the species under observation were:

1. *Padauk.*
2. *Gurjan.*
3. White *dhup.*
4. *Papita.*
5. *Pynma.*
6. *Lambapathi.*
7. White *chuglam.*

EXPERIMENT TO CONVERT IMMEDIATELY INTO PURE AREAS

The object was to start with pure crops. To attain this object a number of plots, each of three or four acres, were laid out. In these plots, the predominating species were determined and only this species was retained, all others being treated as weed growth from the very first weeding.

EXPERIMENTS TO CONVERT INTO TWO-SPECIE MIXTURE

The object was to see how these species behaved in a two species mixture. To attain this object several plots were laid. In these plots the crop was reduced by eliminating all species other than those of the desired mixture into *dhup* and *papita, padauk* and white *chuglam, padauk* and white *dhup, padauk* and *papita, padauk* and *pynma* mixtures. The number of stems in these plots and also their average height were noted. The plants were too small to note their girths.

EXPERIMENTS TO DETERMINE THE EFFECT OF FAST GROWTH ON *DHUP* AND *PAPITA*

Nothing has been done in this direction so far. The writer, however, examined about 100 *papita* trees at site as they were being felled, to find out what has been responsible for the formation of such thin walls in some *papita.* Careful notes were made on the environments, soil, etc., of the tree, and a note was being prepared for publication, though it was not possible to come to any conclusion. It was then observed that when fresh cut, some trees showed wood of pinkish tinge, while others were starch-white. The whitish-coloured wood appeared to be of loose texture and this was more pronounced where the tree was buttressed. Whether the variation in colour was due to any variation in species or not it was not possible to say; further observations are necessary (all notes in this connection were lost at the time of evacuation).

EXPERIMENTS TO DETERMINE THE BEST ROTATION

The age of *padauk* cannot be determined from annual rings. Todd in 1906 measured 50 trees on Chatham Island in Port Cornwallis. This island was cleared of jungle in 1792 in order to establish a settlement. This was abandoned in 1796. The age of the trees was taken to date from this year and a mean annual girth increment was thus determined.

This was .67 inch. Subsequent measurements of 63 trees in a sample plot extending over three years gave a mean annual girth increment of 0.6 inches. This gives a rotation of 161 years to 180 years for a girth limit of nine feet. (Troupe's *Manual of Silviculture of Indian Trees,* Vol. 1, page 278.)

Similarly, *gurjan* sample trees were under observation. The observations for three or four years (papers were lost at the time of evacuation) showed that the rotation of 220 years is needed to attain a girth limit of nine feet.

Intensive study on an extensive scale in connection with the revision of the working plan, however, revealed the fact that the development of our timber trees varied according to localities. In the North Andaman Island, *padauk* above seven feet in girth was rarely sound, while they were not usually unsound up to nine or ten feet in the South and Middle Islands. *Gurjan,* the next most important species of these islands, is a collective name for all *Dipterocarpus* found in the Andamans. A similar study in their case showed that their development differed according to species. *Dipterocarpus alatus,* the giant of these forests and the most common, reaches an enormous size, 20 to 25 feet in girth and 100 feet clear bole, and yet remains sound, whereas others, especially *Dipterocarpus grandiflorus,* the next most important *gurjan,* rarely reaches nine to ten feet in girth before it reaches its physical age-limit and dies and disappears.

It was also revealed that *Dipterocarpus alatus,* unlike other *gurjans,* is unable to reproduce itself freely and the trees now in the Andaman Forests are mostly above nine feet in girth. The result, therefore, especially in our recently-felled areas, has been disastrous, with the very marked absence of mother trees for future regeneration. It was, therefore, found absolutely essential to raise the girth limit of this species to nine feet and to lower that of others to seven feet.

But unless one is a botanist, the difference between these trees is not easily understood. Fortunately, however, *Dipterocarpus alatus* grows mostly in riverain tracts (low-level evergreen forests) while others are confined to hills and hill slopes. Therefore, in subsequent schemes for exploitation, the following girth limit has been provisionally adopted:

Padauk—nine feet—In South and in Middle Islands as far as Webi and Lewis Inlet Ranges.

Padauk—seven feet—In North and in Middle Island North of Webi and Lewis Inlet Ranges.

Low-level *gurjan* (*Dipterocarpus alatus*)	10 ft.
High-level *gurjan* or Hill *gurjan*	7 ft.
White *dhup* and *papita* ...	6 ft.
White *chuglam* and others ...	7 ft.

CHAPTER X—CONCLUSION

The future problems are many and they grew up as the newly-created crop grew up; will grow further as the newly-created crop grows further. Some of the problems, chiefly future management of the mixed crop, appear hard to solve and are worrying many. It is true that it took 50 years to solve the main problem—obtaining regeneration and securing their development. But then the field was new. Now, with all the experience behind us, it should not be hard to solve the problems as they arise and, in fact, some of these problems would have been solved by now but for the trick played by Fate which caused temporary evacuation. But it is the lot of every forest officer to worry himself over the future because, it is not given to him to see the fruits of his own efforts, unless some kind god gives him an extension of his life, in this case 150 years—the present rotation of *padauk*.

(*Concluded.*)

EXTRACTS

PREVENTION OF HOUSE-FLY BREEDING

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A newspaper with a very wide circulation in India recently said: "An article by an investigator and an editorial note in the latest issue of *Leprosy in India,* the quarterly of the Indian Council of the British Empire Leprosy Relief Association, deals with the domestic fly. It has long been under suspicion as a carrier of leprosy. Many investigators have found some evidence that it can act as a disseminator. There is, however, no reason yet to believe that it plays an important part in transmitting the disease. Such evidence on the subject as exists, however, adds yet one further cause to the many previously existing ones for avoiding flies and destroying as many as possible." The house-fly is a much-dreaded enemy of man. Both scientific evidence and general observation that several fatal epidemics among adults and children are associated with the increase in house-fly population have caused the house-fly to be regarded as a source of serious danger to human health. The house-fly's habit is to enter human habitations, feed on man's food, drink animal excrement of all sorts and to breed in dung and garbage. Though the dangerous nature of the house-fly is recognised, the campaign against it is quite inadequate at present.

Definition.—The popular term "house-fly" is used for the small two-winged insects that enter houses and visit food, provisions like meat, fish and fruits and decaying animal and vegetable refuse thrown out. They lick the food they desire to consume, are very active and when driven away frequently come back very soon to the same spot. In India, as in many other tropical countries, there are several species of flies of the genus *Musca* which go under the popular name of the house-fly. All these are about a quarter of an inch long and mouse-grey in colour. Minute differences in structure and colour mark the different species.

Life-history.—All house-flies seem to breed mainly on cowdung or other animal excrement. Fresh dung is most suitable for their breeding and eggs seem to be laid from about half an hour after the dung has been evacuated to about twenty-four hours later. Eggs hatch and produce maggots; the maggot, when full-grown, passes through a resting stage when it looks like a seed and is called "pupa." Inside the pupal case the maggot develops into a fly which comes out of the case by bursting it open with the aid of a collapsible bladder-like process on its head.

Rapid Multiplication.—The house-flies breed throughout the year. In early summer these flies take 12 to 14 days to grow into adults from the egg stage. This developmental period becomes shorter in the hottest part of summer and longer in winter. The adults pair and lay eggs soon after emergence. Multiplication is very rapid and on a large scale, considering that each pair is capable of giving rise to about 150 progeny and fresh broods develop once in every 20 days. Many practices of human society favour them with food, shelter and suitable breeding places.

Carrier of Disease Germs.—The house-fly, both by its habits and structure, is always transmitting disease germs and thus spreading disease among human beings and domestic animals. It is particularly attracted to filth around dwellings and feeds on excrement, vomit, sputum, all sorts of decaying matter and the most carefully prepared human food everywhere whether in hut, barrack, tenement or palace. In passing from one place to another it collects germs and filth all over its body, particularly on the fine hairs around its mouth and on the bristly hairs and sticky pads of its six feet. As it feeds on foul matter its intestinal contents become charged with infective material. The house-fly vomits droplets of liquid on foods like sugar, to be

able to lick the material. The "vomits" and the wet fœcal matter "specks" which it frequently voids take with them the infective material previously swallowed. The flies that develop from maggots that have lived in infected media and have taken in certain infective substances go about carrying and distributing the infection. By accidentally dropping into drinks, especially milk, the flies infect all such liquids. During an inquiry it was found that the number of disease germs on the body of a single fly may range from 800,000 to 500,000,000. Inside its intestine a fly may carry from 10,000 to 330,000,000 germs. As a distributor of germs the house-fly has no other insect to compare with it.

House-flies are known to transmit (1) gastro-intestinal disease such as typhoid fever and cholera and dysentery; (2) "yaws" or tropical ulcer; (3) ophthalmia; (4) eggs of parasitic worms; (5) tuberculosis; (6) anthrax and (7) tapeworms of fowls. House-flies are, according to recent studies, strongly suspected as the carriers of the virus of infantile paralysis and of summer diarrhoea of infants.

In warm climates house-flies are most annoying disturbers of rest. Troops have been often troubled and unable to get any rest or even to consume food and drink owing to swarms of flies settling on them.

Prevention of Breeding.—As has been explained above, the house-fly is the greatest enemy of man's health and comfort in peacetime; and to the soldiers in the field in wartime it can add to other problems with extra intensity the menace of irritation and epidemics. It has already been pointed out that house-flies breed in most accumulations of decaying and fermenting animal and plant substances. The house-fly can fly distances of ten to twelve miles. That we should allow house-flies to multiply and then make efforts which are expensive, to kill them is a very unsatisfactory state for our civilization. We should not permit the breeding of house-flies.

For the destruction of house-flies it is necessary to:

(1) take sanitary precautions to prevent flies from entering houses and getting at and contaminating food by fly-proofing with fire gauze all doors and windows and keeping provisions, food and drinks and garbage and excrement inaccessible to them;

(2) adopt sanitary measures to eliminate as far as possible the breeding places of flies by planned disposal of all refuse; and

(3) dispose of all household and municipal refuse in such a manner that house-flies cannot breed in them and all immature stages of house-flies in them are destroyed and no adult flies can emerge from them. For this purpose incineration is the only method till now known to be completely effective.

New Method for Disposal of Refuse.—As the breeding of house-flies takes place in dumps of cowdung, horsedung and garbage of all sorts, organized and continuous attempts should be made to prevent such breeding. Except incineration other methods are not quite successful and are expensive. Incineration is often disapproved of as the process destroys material in great demand as manure for raising crops.

Recent investigations by the writer have shown that dung or garbage or other such material in which house-flies are breeding could be buried in such a way that flies could not breed in it and in the case of dung it could retain its manurial value.

Dung is only attractive to house-flies for egg-laying up to 24 hours after it has been evacuated. Fly maggots can breed in it only during the first few weeks when it is fermenting and warm. The maggots, when full-grown, leave the feeding ground to get into dry soil near the surface to turn into the pupal stage and then emerge as flies. It generally takes, as has been mentioned above, at least nine days for a fly to develop from egg to adult. The maggots do not like the sunlight or very damp soil. If fresh dung and garbage are filled into deep pits in fairly hard soil up to a foot below the surface, levelled and covered up with about a foot of earth applied in three layers, each four inches deep, and each four-inch layer

successively rammed down, wetted to about 2-inch depth and pressed down again, there is no emergence of flies.* The closing of pits in this manner keeps in the heat due to fermentation in the dung and garbage and raises both the temperature and humidity within the mass so as to kill the trapped maggots. As flies develop from eggs into adults only in about nine days these pits or trenches need be closed up only after seven days. Such pits also act as traps against fly multiplication as during all these seven days when the daily refuse is being put into the pit the decaying refuse is attracting flies to lay eggs in them.

In conclusion a statement by Dr. L. O. Howard, perhaps the greatest Economic Entomologist of our time may be quoted here. It runs: "The truest and simplest way of attacking the fly problem is to prevent them from breeding by the treatment or abolition of all places in which they can breed."

FOREST PRODUCTS LABORATORY, KAITING: AN OUTLINE OF ITS PLAN AND WORK

National Bureau of Industrial Research, China, Ministry of Economic Affairs,
(*April,* 1943)

Our Forest Products Laboratory belongs to the National Bureau of Industrial Research of the Ministry of Economic Affairs and was organized in the autumn of 1939, at Peipei, Chungking. Its purpose is to promote the more economical use of our forest resources. Unfortunately, our building was destroyed by Japanese bombing on June 24, 1940. We then determined to move this newly-established laboratory to Kaiting, which is more near to our forest resources.

Through the co-operation and help from various Institutes, especially the Fan Memorial Institute of Biology, the Rockefeller Foundation, the Agriculture Promotion Association and the National Wu-Han University, this laboratory possesses the facilities to carry on the investigation on Chinese timbers along many lines. Furthermore, Dr. Tang brought back more than 6,000 copies of pamphlets pertaining to the studies of timber. He also photographed a great deal of literature with biblo-films while he was in America and Europe. The laboratory possesses more than 5,300 authentically determined timber specimens representing over 1,500 genera and more than 3,000 species of trees. Although we lack equipments and many heavy machineries, a number of preliminary results have been accomplished due to our hard struggle. The following is a short account of our plans and the progress during the past thirty months.

PART I.—ITS POLICY, ORGANIZATION AND PROGRAMME

In order to investigate the properties and uses of our timbers, we have laid down the following projects for our work:

First, to promote and assist the other institutes to carry on the survey of our forest resources and study our logging operations. *Secondly,* to investigate on our lumber markets and our forest product industries for collecting the information and specimens. *Thirdly,* to carry on our routine tests on our important commercial timbers of their structure and many technological properties. *Fourthly,* to build up experimenting plants for improving the properties and uses of our timbers. *Lastly* to render services relating to timber to other Governmental institutes and private industries.

The following is the tentative scheme of our organization:

A. Sections of General Services.

* In the original article a plate indicated the importance of ramming down each four inches of covering soil separately.—*Ed.*

B. Technical Sections:

Group I—Biological Section: Studies on Wood Anatomy, Wood Technology, Wood Pathology and Insect Injuries to Wood.

Group II—Physico - mechanical Section: Studies on Timber Physics, Timber Mechanics and Lumber Seasoning.

Group III—Chemical Section: Studies on Wood Preservation, Wood Chemistry.

Group IV—Industrial Section: Studies on Wood Working, Logging, Sawmill and other allied subjects.

Part II.—Its Progress

Although we have met tremendous difficulties, limited by budget and lack of trained staff, we are very glad to say that we have created a rather new surrounding which gradually enables us to study problems relating to Chinese timbers.

Through the generosity of Dr. H. Hu, Director of the Fan Memorial Institute of Biology, all the timber specimens, equipment and pamphlets on this special line have been shipped from Peiping to Hongkong in 1940. Together with the rich collections made by Dr. Tang while he was abroad, we are fortunate enough to get them from Rangoon to Kaiting in October 1941. This is mainly through the effort of Dr. Y. T. Ku, Director of our Bureau. With the addition of almost two tons of treasures, we now possess a special and well-organized library which is comparable to our sister institutes in the world. Furthermore, we have a very large collection of authentically determined timber specimens which we have collected all over China and exchanged with other institutes throughout the world. The following is a brief resume of the important works which we have accomplished:

(I) Survey of Forest and Lumber Markets.—Mr. K. Wang, our Senior Assistant, undertook an expedition to Sapin in 1940, to Lifan in 1941, for collecting testing specimens and field information. He also made a long expedition from Szechuan to Kweichow, Kwangsi and Hunan in 1942. Mr. P. F. Ko, our Research Assistant, made a study on forests and lumber markets along Ching-Yi River. There have been more than 500 authentically determined timber specimens added to our collections.

(II) Studies on Structure and Identification.—Dr. Tang, Director of the Laboratory, continues his studies on wood anatomy of Chinese trees. To meet the urgent needs, *a Preliminary Manual of the Chinese Commercial Timbers* was published in 1941. Mr. Y. C. Chen, Junior Assistant, has been working on Technology since June 1942. Mr. Y. C. Tai, Senior Technician, has been doing active work on the preparation of sections of Chinese timbers. More than 600 slides of Chinese timbers have been prepared.

(III) Physico-Mechanical Tests.—To reveal the variabilities of the properties of wood, we carried out an intensive study on the determination of the physical properties of *Quercus acutissima*. The basic specific gravity of 144 species has been worked by Mr. H. Y. Tu, Senior Assistant on Timber Physics. Other physical properties as the shrinkage of wood, equilibrium, moisture content, etc. are under investigation.

Through the kindness of the National Wu-Han University, we are able to carry on the mechanical tests. We have made more than 2,000 tests in the green condition of *Schima crenata* and *Castanopsis platyacantha*. A preliminary report is under preparation. Furthermore, records of the toughness of many Chinese timbers have been worked out and published.

(IV) Other Work.—In addition to the work mentioned above, we have started exposure tests on the natural durability of some Chinese timbers in June 1941. Problems relating to decay, chemical seasoning, our important forest trees, logging operations, small sawmills, wood working properties and lumber industries are also studied from time to time. A small kiln chamber and several testing equipments have been designed and built up to meet our special needs.

As a result of our efforts, more than 50 technical papers have been published. The

following is a list of our important papers:

(1) Y. Tang: Outline of Works of the Forest Products Laboratory. N.B.I.R., Ministry of Economic Affairs, Special Bulletin No. 3, published by the Laboratory, 1940.

(2) Y. Tang: A Preliminary Manual of the Important Chinese Timbers, Technical Bulletin No. 1, 1940.

(3) Y. Tang: A Preliminary Survey on the Uses of Chinese Woods and Seasoning of Timbers, Special Bulletins Nos. 14-15, 1941.

(4) Y. Tang: Moisture in Wood with a Note on the Moisture Distribution of Chinese Oak, Special Bulletins Nos. 17-18, 1941.

(5) Y. Tang: Shrinkage of Wood with a Note on the Variation of a Chinese Oak, Special Bulletins Nos. 19-20, 1941.

(6) Y. Tang: Density and Specific Gravity of Wood with a Note on the Variation of a Chinese Oak, Special Bulletins Nos. 21-22, 1941.

(7) Y. Tang: Toughness of Wood with a Preliminary Study on the Toughness of some Chinese Timbers, Special Bulletin, Vol. III, No. 2, 1941.

(8) Y. Tang and M. Y. Tu: A Preliminary Study on the Basic Specific Gravity and the Calculated Mechanical Properties of some Chinese Important Timbers, Spec. Bull. Nos. 31-32, 1943.

(9) K. Wang: Survey of Lumber Market in Chengtu. Bull. National Central Bank, IV. 2, 1941.

(10) K. Wang: Survey on Logging Industry in Western Szechuan, China. Spec. Bull. Vol. III, No. 1, 1942.

(11) K. Wang: Survey of Lumber Market in Loshan. Bull. National Central Bank, III, 11-12, 1940.

(12) P. F. Ko: Survey of Lumber Market along Ching-Yi River, Bull. The Farmer Bank of China, IV, 5, 1943.